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NIAGARA MEETING OF THE AMERICAN ELECTROCHEMICAL SOCIETY.

It is appropriate that the newly-fledged American Electrochemical Society should hold its first meeting away from its birthplace at Niagara. The general meeting there next week calls attention to the swift strides with which the industry as represented by the works using Niagara power, and the profession as represented by the society, have been advancing. When the great project of the utilization of Niagara power was undertaken there was doubtless little thought that before its entire completion a new industry would arise which, nestling close to the seat of electrical generation, would entirely modify the original plans for the disposition of the electrical power transformed from the energy of the great falls. At present there is almost a score of separate electrochemical establishments settled at Niagara, some of which are already significant factors in our national industry, and several others give promise of developments revolutionary in their effect. Indeed, if some of the processes now in an experimental stage at Niagara work out successfully, the electrochemical industry as a whole will be given a new and wonderful impetus.

It is with regret that we learn that the Niagara plants upon the occasion of the visit of the society will only in a few cases depart from the practice that has obtained, of refusing admittance to their works. This practice was doubtless borrowed from the chemical industry, which itself imported it from abroad. Such a policy of seclusion is not only un-American, but it is futile so far as concealing the details of processes in regular commercial working. In every other line of electrical manufacture American works are open to properly accredited visitors, and there is usually competition for the privilege of a place on the programme of the American Institute of Electrical Engineers for a visit while the members are *en route* to or in attendance on the annual convention. And if any one thing has been thoroughly demonstrated in this wideawake country, it is the fact that competitors in the same line of work can always find means to know what their rivals are doing, particularly when the process is in commercial operation and known to employees who, when they quit the works, cannot be bound to secrecy as to what they have learned.

The Niagara programme of the American Electrochemical Society is of even higher quality in some respects than that of the Philadelphia meeting, which latter at once gave to the society a high rank among the professional bodies of the world. The papers as thus far announced are 23 in number and cover a wide range of subjects, practice and theory being well combined. The electric furnace is naturally well represented, and a paper by Prof. Richards on its efficiency deals with a subject of particular interest. Prof. Carhart will present another contribution on his paradoxical nickel concentration cell, and the subject of electro-metallurgy of iron and steel will be considered in a paper by Mr. Marcus Ruthenberg. Mr. Alfred H. Cowles will discuss the matter of a unit of quantity of electricity for use in electrochemical calculations, which we trust will not advocate any proposition at variance with the general system of electrical units. Among other subjects of special interest are, the electrolytic dissolution of soluable metallic anodes; cathodic production; some phenomena of electrolytic conduction, and a paper by Prof. R. S. Hutton, of Owens College, Manchester, Eng., on the fusion of quartz in the electric furnace. A paper by Mr. Arvid Reuterdahl on the electronic hypothesis will furnish an opportunity for a discussion on modern electrochemical theory, which doubtless will be taken advantage of. A

paper, the title of which is not yet announced, will be read by Prof. Dr. F. Haber, of Karlsruhe, who will attend the meeting as the accredited delegate of the German Electrochemical Society.

N. E. L. A. Membership.

The new spirit infused into the National Electric Light Association under the administrations of Presidents Cahoon and Doherty is illustrated by the statement that a membership of 117 at the Chicago meeting two years ago, has been increased to 266 at the present time. No less than 85 new members have joined since the Cincinnati convention, their adhesion doubtless being largely due to the remarkable success of that meeting, from both the technical and managerial standpoints. If the progress of the past few years is continued—and there is no reason to believe that it will not be—there is every prospect that the association will eventually become in numbers more truly representative of the industry than it has been in the past. Though now including the greater number of large stations, there remains a vast possible constituency among the total of over 3,500 American central stations; and nothing could aid more in a successful canvass among these than the earliest possible announcement of a programme for the next convention which will vie with that of Cincinnati in live interest to the central-station man.

Load Factor in Power Distribution.

In an article printed elsewhere in this issue descriptive of an electric power plant in a steam railroad shop, an analysis is given which shows that in this particular case the motor equipment is operated at only about 37 per cent. of its rated capacity. It is perhaps needless to say that this does not reflect on the motor equipment, being due to the infrequency at which the machines driven are employed in actual work. Moreover, in the case of a shop largely dealing in repair work, and consequently necessarily fitted with tools only occasionally in use, a considerable disparity between connected capacity and the actual load is inevitable. But the figure given is significant when we consider what it would mean if the shops were shaft-driven by a steam engine. In the present case a considerable part of the capacity is in direct-connected motors, and it is to be assumed that where shafting is employed full advantage has been taken of the economy in disposition incident to a motor drive. If, however, the shops were operated from a system of shafting driven by a steam engine, the low load factor of 37 per cent. would entail a distressing loss of energy in the shafting. In the case of a large shop, somewhat similar in character to that described in the article, the load with all the machines idle was found to be 57 per cent. of the normal load during the working hours; with an electrical distribution this perhaps would have been reduced to the odd 7 per cent. We have no doubt that the low load factor quoted had in itself much to do in the present case in influencing the railroad company in the adoption of electric power in the face of special circumstances, which, as pointed out in the article, militated against such action. As to the matter of the load factor itself, this is conditioned on the character of operation in any case, and very difficult of amelioration. Electric power, however, offers a means of reducing its untoward effect to a minimum.

Electricity and Slumber.

In thought one is not apt to associate electricity with sleep, nor seek in it an agent for producing slumber—at least of the reposeful kind that has an awakening. In the Digest of this issue, however, will be found an account of some experiments which appear to indicate that insomnia may find in the electric current a dangerous foe; and as the authority for the statements is not a newspaper writer but a French physicist of authority, the matter takes on a real interest. It is true that the apparatus necessary is somewhat formidable, and that in the case of the animals experimented on, the first step consisted in producing apparent death, from which the subject was resuscitated to the intermediate stage of slumber. But even this condition would not deter one so afflicted with insomnia as to render any remedy however heroic the lesser evil. An insomnia is the result of a disturbance of the nerve centers, it appears reasonable that a titillation properly set up by an interrupted current at such centers should have some effect, and perhaps a tranquillizing one; but whether it could be one oft repeated or have a permanent curative power is a matter for neurologists rather than physicists to pass judgment upon, and the verdict of the former will be awaited with interest.

Deterioration of Storage Battery Plates.

It is a trite observation that the efficiency of dynamos is already so good that there is but little room left for improvement in this direction. While this is true, there is ample room for possible improvement in the size, weight and cost of dynamos for a given output. The demand for improvement in the dynamo is, however, not merely so great as the demand for improvement in the storage cell. When we consider that a lump of good coal is theoretically capable of lifting itself two thousand miles high against sea-level gravitation, by virtue of its contained potential energy, whereas a lump of storage battery can at best only lift itself about ten miles, the disparity between the storage of electrochemical energy, and the storage of chemical energy in carbon becomes painfully apparent. Nevertheless the low efficiency of the steam-engines commercially used on vehicles for the transmutation of coal energy into work goes a long distance towards placing coal and the storage-battery on a par as energy carriers. At least, until recently, the lead storage cell has held undisputed sway among commercial accumulators. It is an irony of fate that for the electrical propulsion of automobiles, batteries of the heaviest commercial metal must be used and carried about.

It is not so much a question, however, of the weight, or even of the efficiency of an automobile battery, as it is its reliability. If the storage battery runs the automobile 20 miles to-day, can it be relied upon to do so after recharge to-morrow or next week? It is the depreciation of batteries that has brought them into discredit far more than their weight. In an article on page 409 of this week's issue, Prof. A. L. Marsh suggests that silver might be made to replace lead in a storage cell, were it not for the first cost. While it is true that the first cost of a silver battery would constitute an objection, yet if a silver battery could be made light, efficient and reliable, so as to have a small depreciation under commercial conditions, it might supersede lead for automobile traction. Tramps might occasionally run away with an automobile for the sake of its silver battery, but the value of a light and reliable accumulator would pay interest on a considerable first cost of battery. Of course, for stationary storage cells, silver has very little chance, and the leaden cell has every chance of surviving; but for automobile propulsion, the survival of the fittest means the survival of the lightest.

Wireless Telegraphy and Maxwell's Theory.

An article on this subject appears in our columns this week, and is closely in line with our views on the subject. The full significance of Maxwell's theory of electric wave transmission required the development of wireless telegraphy to elucidate. Not only is modern wireless telegraphy in accordance with Maxwell's theory, but also, in a certain sense, a full knowledge and complete understanding of Maxwell's theory would entail a conception of modern wireless telegraphy. Unforunately, Maxwell was so pre-eminently a mathematician that his results remained for many years enshrouded in symbolic language, and appreciated only by the esoteric. Even at the present time but little progress has been made in enlightening the process of the propagation of light and other etheric waves.

It is a significant fact upon which the practical success of marine wireless telegraphy depends, that sea-water is opaque to electromagnetic waves of comparatively great wave length, although very fairly transparent, as we all know, to the shorter waves that we recognize as luminous. In other words, sea-water is a good conductor to waves executing several millions of cycles per second, but is a fairly good insulator to waves of some 500 trillions of cycles per second. If we had eyes that responded to the low frequencies or to the light colors which those frequencies accompanied, a layer of sea-water would be almost metallic in its opacity. Expressing the matter in still another way, if a marine fish carried coherers it would be impossible to operate the same at any considerable depth below the ocean level with the frequencies of wireless telegraphy; but with luminous frequencies, coherers in fairly deep-sea fish might be actuated.

An electromagnetic disturbance impinging upon the sea must either be reflected from it as from a mirror or else travel along the surface, provided that the frequency is not more than millions per second. The disturbance cannot penetrate very deeply. But if the frequency is reckoned in trillions per second, the disturbances may be all reflected or nearly all transmitted to a considerable depth before being destroyed, according to the conditions of the impact. But when a wireless wave travels along the surface of the ocean, oscillating currents flow on and near the surface; and if a current indicator could be made sufficiently delicate, such an indicator, floating on the surface of the sea, might serve as a detector of the electric waves running over it. The current in a long antenna terminating in the sea would, however, be probably much stronger than any local and superficial current on the ocean surface. An enormous amount of detail yet remains to be learned and explored concerning wireless waves, but their main outlines have been implicity contained in Maxwell's theory for many years, and may be said to be definitely known. As pointed out in the article, there is a common ground upon which nearly all theories of wireless telegraphy unite. The orthodox theory embraces each of these theories as one of its aspects, and all the contestants have at least a certain amount of the truth on their side.

THE SHADOW OF DISASTER.

Only a few weeks since we sounded a note of warning regarding a dangerous phase of electric railroading. To this the disaster of last week, which brought the President and the Governor of Massachusetts within a hair's breadth of death, serves as grim and dreadful confirmation. That they were spared to the Nation and State was due to no human interposition. It is a terrible and ghastly thing that such an accident could occur in broad daylight with full knowledge of the conditions, and in spite of such police protection as the city was able to furnish. It is not our place to sit in judgment on the men who may have been directly or indirectly at fault, for the courts will settle the matter of responsibility in so far as any tribunal has the power. Nor do we propose to discuss the details of the catastrophe—we cannot call it an accident—for until these are brought out under oath they must remain somewhat uncertain. But the broader aspects of the affair are as clear now as they ever can be, and the relation of these to the public weal is no light matter. It is not the particular manner of the occurrence, but that it could have taken place at all that is of the greatest moment.

Whatever may be the judicial decision as to the culpability of the parties to the horror, the fact remains that a car running under full control of the motorman and below the legal rate of speed could not have produced the results that are all too plainly in evidence. Whether the brakes were inadequate or out of order, the reversing gear cramped and inaccessible, or its use forbidden, the motorman reckless or demoralized, the conductor negligent or the management heedless in allowing the cars to be run at all, these are questions of fact to be decided later. That the President's carriage turned to cross the tracks and was immediately run down by the car admits of no dispute. Presumably the motorman did not expect the carriage to cross the track at that particular point, but it was no business of his to read the driver's mind. It was his business to keep his car under complete control, whether his rubber-necked passengers got a good view of the Presidential party or not. It was his business to keep his car under complete control whenever there was any chance that a carriage might get in the way, whether it contained the President of the United States or the humblest citizen. We know well the hard and nerve-racking duties of the motorman; we know that there are accidents that no human skill and prescience can avert; but running down from the rear a smartly driven carriage by an electric car at its legal limit of speed cannot be relegated to this class of occurrences. The truth is that with the modern fast and heavy electric cars there is little pretense of keeping the cars under control except in the most crowded part of the city. Even with the best automatic brakes it is hard to keep control unless the speed is low, and this particular car had only hand brakes. As to the legal limit of speed, it is a fact well known to every qualified observer that it is systematically and persistently exceeded almost everywhere and at all times. We know of no adequate legal provisions for enforcing such a limit, for violation in face of the uniform denial of conductors and motormen is very difficult to prove, and the penalties are utterly ineffective. The Pittsfield disaster, to speak frankly, is simply an exemplification of the insufficient grasp which the public has upon its servants.

We are far from being champions of municipal ownership and management of street railways and the like. On the contrary, we have over and over held up to scorn the fallacies of the municipal ownership enthusiasts. In the present state of American municipal politics even close public regulation of public utility is fraught with danger of degenerating to legalized blackmail. But a long line of trolley catastrophies has shown that however good the intentions of the managers may be, they too often fail of ensuring public safety. And they do not stand alone in their ineffectiveness, for less than 24 hours prior to the Pittsfield affair two trains on the Boston and Maine Railroad collided at a crossing and missed terrible loss of life only by the fraction of a second. It was the old story of trains hurrying to make up time and cutting too close at the crossing. The question of immediate public interest is not so much the details of any one accident as means for prevention of all accidents due to reckless running—that is, running with train or car under incomplete and inefficient control. Neither managers, engineers or motormen desire accidents—on the contrary, they suffer by them; but to put the matter in a nutshell, they sometimes imperil the public to meet the temporary exigencies of business. The control of this element of danger is no easy matter. A single reckless man can be landed in the penitentiary if life is lost by his carelessness and negligence; but you cannot get an adequate grip on a corporation. By a pleasant legal fiction it is a person as regards its rights, immunities, and privileges; but when it comes to civil and criminal responsibilities the corporation slips out from under. It cannot be imprisoned for felony or hanged for a wilful murder; it cannot be fined enough to exercise the slightest restraint upon its policy. A single agent may here and there be brought to punishment, but the real criminal escapes. The essential thing to public safety is not so much restrictive regulations as the power to enforce them against the elusive personality of a corporate policy. We pass no judgment upon the management of the Pittsfield road in saying this—it will meet its own vindication or condemnation later. But there is dire need for a firmer grip on quasi public corporations, a grip strong enough to ensure greater caution in operation.

A Memorial to Joseph Henry.

In view of the fact that the president of one of the telegraphic societies in this country wrote recently that he had never heard of Joseph Henry or his work in the telegraph field, it would seem to be high time for the movement set on foot by the Albany Institute to secure a memorial in honor of that great physicist at Albany, the city of his birth. It has been proposed that the various electrical bodies should co-operate actively in this laudable work by appointing a committee and raising part of the necessary money. Mr. Cuyler Reynolds, curator of the Albany Institute and Historical and Art Society, who is chairman of the committee at Albany pledged to undertake and carry through the plan, sends us the following as part of a formal resolution, which is so worded that all societies interested can adopt it as their utterance in regard to the matter:

"That this committee favors a memorial wherein the sciences shall be taught, in connection with the Albany Academy where he taught as a member of the faculty, and within which building he performed the experiment that demonstrated the correctness of his principle of the electric telegraph, believing that it will be more practical than any other type; and thereby holding in cherished remembrance the views and character of the one who has been long recognized as the leading American scientist, and who donated his discoveries to the advancement of knowledge and the world's industries.

"Considering the inestimable advantage that the inventions of Joseph Henry have been to the world, inasmuch as the sum of $4,000,000,000 is invested in this country alone in enterprises that his study and free gift made possible, which industries give employment to more than a million persons, and appreciating the honor of his labors in connection with the work of this organization, we take this step with a feeling that even when the efforts shall be crowned with success it will be but a slight token of the sincere esteem of the country."

Annual Meeting of the American Electro-Therapeutic Association.

The twelfth annual meeting of the American Electro-Therapeutic Association was held at the Hotel Kaaterskill, Kaaterskill, N. Y., September 2, 3 and 4. Forty members were present, and 24 new members were elected. Many papers were presented on Röntgen rays, which was by far the most frequent subject of discussion, occupying the attention of the members fiully half the time of the convention. Ample evidence was given in cases cited of its efficacy in skin diseases, particularly in carcinoma, lupus and rodent ulcers, its effect being first to remove all pain, and then to heal up granulations, and suppuration, diminishing the tumor in size, and finally curing it. It penetrates the tissue right down to the tumor, and supersedes the knife, which only too often auguments the trouble. It is of unquestioned service in diseases of the lymphatic system. The claims which have been made for it, however, in the cure of consumption were called into question, satisfactory proof of its value in this field being absent. The general feeling was that it would be wise to work and wait rather than promise too much for this new agency. The rest of the papers covered the somewhat limited area over which electrotherapy has been approximately standardized.

Among the matters considered by the convention was the place to be given to electro-therapeutics at the World's Fair of 1904. The subject was presented to the convention through the president by recommendation of the executive committee, and an animated discussion ensued. The trend of the discussion showed that the members were greatly interested in having a true picture of what is being accomplished in electro-therapeutics along strictly scientific lines presented for the criticism of the world. There was a strong feeling that too much light cannot be thrown upon electro-therapeutic methods; that no effort is too great which will stimulate the medical and electrical professions to earnest search after truth; that every effort must be made to instill confidence in that which is good, and brand with its proper mark all charlatanism. At the close of the debate, by unanimous vote, a resolution was passed heartily commending and supporting the plans that have been inaugurated for organizing an electro-therapeutic exhibit commensurate with the dignity and importance of this branch of electricity.

There was a strong sentiment expressed in the discussion of this resolution in favor of the association being represented at the exposition by an appropriate exhibit of the work which it has accomplished, and to further the project and to lend such assistance as may be possible to the Department of Electricity in arranging for the general electro-therapeutic exhibit at the exposition, by vote of the convention, the president of the association was empowered to appoint a special committee of the association on electro-therapeutics at the Louisiana Purchase Exposition.

Prof. W. E. Goldsborough, chief of the Department of Electricity at the Exposition, was present at the convention and by invitation of the president explained the plan and scope of the Exposition. His address was received very warmly by the members, and a strong sentiment developed in favor of holding the 1904 meeting of the association in St. Louis.

Municipal Ownership.

At the convention of the League of American Municipalities, held at Grand Rapids, August 27 to 29, inclusive, Mayor Ashley, of New Bedford, Mass., in his presidential address, advocated in general the municipal ownership of public utilities, more particularly water and electric light plants. While the question of municipal ownership did not come out very strongly at the meeting, it was advocated by several members, especially the Hon. Ignatius Sullivan, the "Labor" Mayor of Hartford, Conn., who was, perhaps, the most pronounced municipal ownership man present at the meeting. Mr. James B. Cahoon, the secretary of the National Electric Light Association, secured the floor at the end of the morning session on Friday, and almost following an address by Mayor Sullivan, made the following proposition to the league in behalf of the National Electric Light Association:

The Association would bear one-half of the expense of a competent engineer and public accountant to the extent of $5,000 for their services; such engineer and accountant, or engineers and accountans to be mutually agreed upon by the presidents of the two associations, to examine and report on the costs of any municipal operated plants that the presidents of the league might select, and to compare the costs of the same with the published costs of a private plant of similar size and operated as nearly as may be under similar conditions as regards cost of coal, etc., so that the comparisons could be made on the basis of cost per kilowatt-hour, delivered at the lamp.

In his address, Mr. Cahoon went into the subject somewhat fully, laying particular stress on the subject of uniform accounting, which he informed the league had been adopted by the National Electric Light Association, and which they were at perfect liberty to apply to their plants. At the conclusion, Mayor Smythe, of Charleston, S. C., moved that the matter be referred to the executive committee. The president modified it by suggesting that the National Electric Light Association submit their proposition in writing to the executive committee through the secretary of the league, and that the matter be taken up between now and the next convention, and a decision arrived at, whether they would accept or reject the proposition. The president explained that the reason he did this was because almost all of the members of the league there present were new to the workings of the league and to the proposition submitted, and were entirely ignorant of what had gone on before at Syracuse and Charleston. He stated that this would give them a chance to study the subject over and act on it in an intelligent manner.

Mayor Smythe stated further that he had always understood that the league was against committing themselves in one way or another in favor of, or against, the question of municipal ownership. Mr. Cahoon explained to him that the object of the National Electric Light Association was not to agitate this question as to the advisability or non-advisability of municipal ownership, but rather to look at it from a straight business point of view, as to whether a municipality could operate a plant cheaper than the members of the association could. If it was found that they could do so, then private plants must necessarily retire from business and seek investment for their capital in other directions; they were thus naturally anxious to arrive at the true costs of operation of municipal plants so as to know whether private plants could, or could not, operate cheaper than municipal plants, when the proper system of costs and a uniform system of accounting were applied to both propositions. He stated further that the association believed private owners could operate this class of public utilities cheaper than municipalities possibly could, for the reason that the latter lacked the incentive to economy which was always present in the privately operated plant.

The Mayor of Waco, Tex., who had a paper on municipal ownership, was not present at the meeting, and, therefore, the specific subject of municipal ownership did not come up for general discussion in such a way that the negative side could be heard from.

Electric Power in Steam Railway Shops.

SINGULAR evidence of the economy of transmitted electric water power is found where a great railway adapts it to the disuse of an existing and extensive steam plant. When the railway in question hauls all the coal used at the point where the change is made, weight is added to the illustration. If the electric water power is purchased by the railway from an independent company that must sell at a profit, the triumph of water over coal is well nigh complete.

All three of these conditions exist as to the large shops of the Boston and Maine Railway, at Concord, N. H. These shops, where much of the roling stock of the railway is built or repaired, cover a ground area of some acres, and are a good exemplification of the advantages of electric power distribution instead of long, heavy shafting or radiating steam pipes and scattered engines. An electric power plant, driven by steam, was installed at these shops in 1897. This plant comprises two Westinghouse alternators of 150 kw each, at 440 volts and 60 cycles, two-phase, each belted to a tandem-compound engine of the Fitchburg make. From the switchboard near the generators, distribution circuits are run to the various buildings that make up the group, and these circuits supply motors with an aggregate capacity of 590 hp. All the motors are of the Westinghouse make, two-phase, induction type, at 60 cycles and 440 volts, and are composed of the following sizes and numbers of each.

Horse-power.	*Number.*	*Horse-power.*	*Number.*
10	1	30	6
15	6	40	2
20	3	100	1
25	2		

The total number of motors is thus 21.

About a year ago the railway company became convinced that, in spite of the advantage of their position as to fuel supply, electrical energy from water power could be substituted for steam with a saving in the cost of operation at their shops. The available water power is located at Sewall's Falls, on the Merrimac River, 5.5 miles from the railroad shops. This water power is owned by the Concord Electric Company, which uses the falls to drive its generating station there, and operate the electrical supply system in the city of Concord. A contract was made between the railway and the electric company, whereby energy from the water power of the latter was substituted for steam at the shops of the former, and the engines and generators at these shops were left to stand idle.

At the water power plant the generators operate at about 2,500 volts, 60 cycle, three-phase, and this energyy had to be transmitted to the railroad shops. For this purpose three transformers of 150-kw each were installed at the water-power station to raise the three-phase energy from 2,500 to 10,000 volts. Three No. 6 bare copper wires were run from the three transformers at the water power to the railroad shops, and there connected with two transformers of 200-kw each, which change the energy from three-phase at 10,000 volts to two-phase at 440 volts for the two-phase motors. At both ends of the line, the transformers are of General Electric make, and are cooled by air blast from motor-driven blowers. In the generator room at the railroad shops the two transformers just named were installed near the then existing switchboard, from which the motor circuits radiate, and were connected to this board through a smaller one at the left hand.

Recording wattmeters connected in each phase of the 440 secondaries from the two large transformers measure the energy delivered from the water-power system to the local distribution lines.

Throughout the shops the induction motors are applied in a variety of ways to the work in hand. One interesting unit is made up of a 100-hp motor, geared to an air compressor. In another case a large transfer table, used to move railway cars from one department of the works to another, is driven by a geared motor of 15 hp.

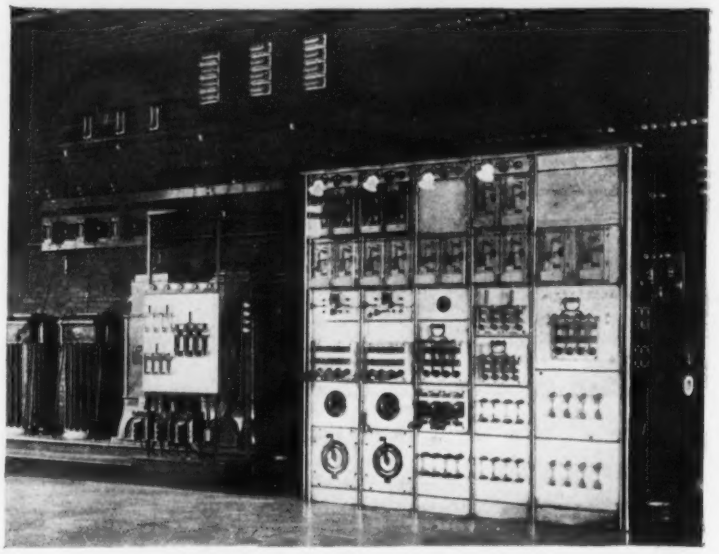


FIG. 2.—SWITCHBOARD AND TRANSFORMERS.

This motor is supplied with energy through an auto-converter, so as to be operated at variable speeds. A large set of plate rolls, used to bend boiler sheets, is driven by a geared motor of 15 hp, operated at variable speeds through an auto-converter. In the wood-working shop are seven motors; in the blacksmith shop, two motors, and in the cabinet and pipe shop, one motor, all driving by belts. A long shaft operates each of the two sides of the main machine shop, and one shaft is driven by a 30-hp, the other by a 40-hp motor, both belted. In this machine shop are two traveling cranes, each of 30-tons capacity and motor driven. Each crane is provided with three motors of 10, 15 and 30-hp capacity, respectively. All of these motors are connected through auto-converters to secure variable speed of operation in the three movements. The 10-hp motor on each crane moves the carriage lengthwise of it. The entire crane with its load is moved up and down the shop by the motor of 15 hp. In each case the 30-hp motor on the crane is used for lifting.

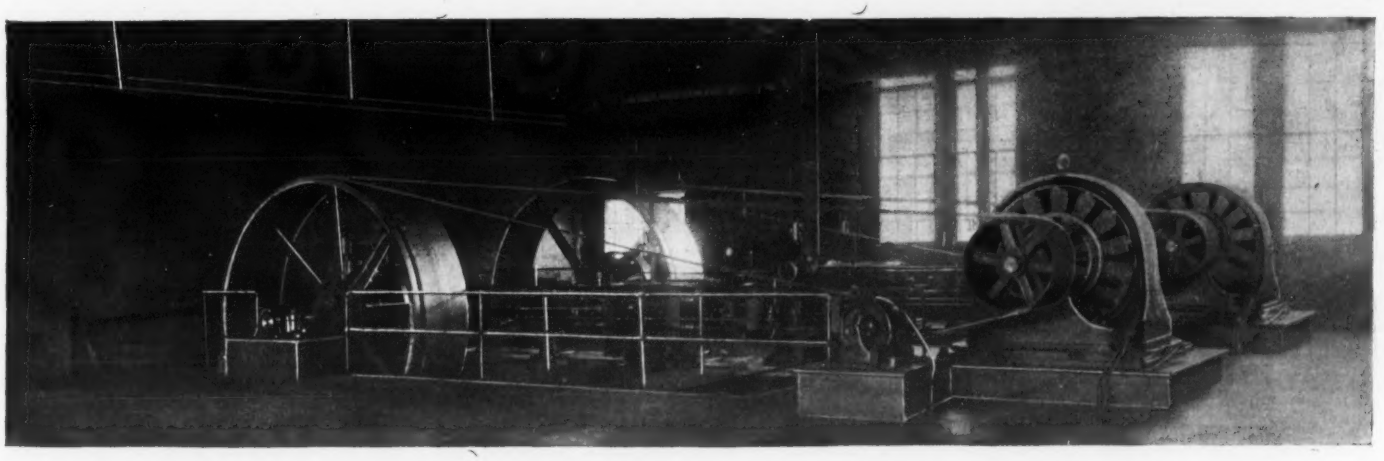


FIG. 1.—VIEW OF BOSTON & MAINE SHOPS POWER PLANT.

For all of these motors, except one of 40 hp, the nominal working time is ten hours every day except Sunday, when no work is done. Working time for the 40-hp motor is 20 hours on each week day, except Saturday, when the time is 16 hours. From May 31 to June 30, 1902, the above motors, all told, consumed energy to the amount

of 57,740 kw-hours. If the meter readings to determine this energy were taken after the close of work on the 31st of May, and after the close of work on the 30th of June, the kw-hours named would represent exactly the amount of energy used by the motors during June. The meter readings were probably taken at same times during the two days just mentioned, but the 57,740 kw-hours may be taken without material error to represent the consumption of the motors during June. There were five Sundays in June, and 25 working days. The nominal hours of work for all motors except the 40-hp were thus 250 during the month. It may be fairly assumed

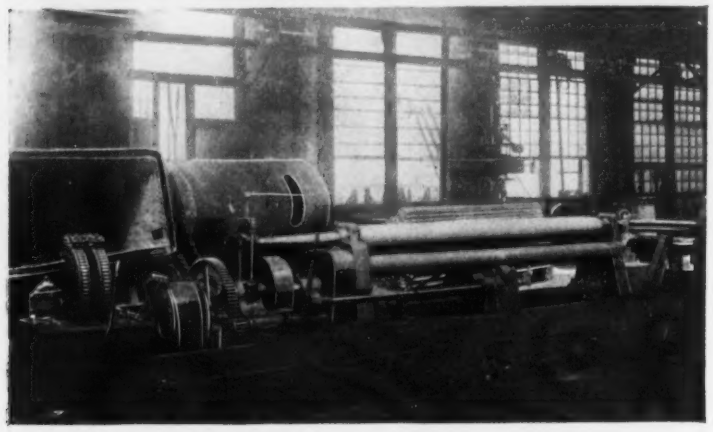


FIG. 3.—TRAIN OF MOTOR-DRIVEN ROLLS.

that these motors working at all stages of load have an average brake efficiency of 74.6 per cent., so that one kw-hour must be delivered to the motor for each hp-hour of work done by them.

The motors of 250 hours nominal working during June were rated at 550 hp. If these motors had been fully loaded during their entire working time, they would have delivered 137,500 hp-hours, and absorbed at the assumed efficiency 137,500 kw-hours. If the 40-hp motor had operated 20 hours per day during each of the 25 working days of June, its time of service would have been 500 hours, but 16 hours must be deducted from this time, leaving 484 hours of nominal work, because this motor works only 16 hours on Saturday, and there were four Saturdays in June. On the foregoing assumption as to efficiency, the 40-hp motor would have absorbed 19,360 kw-hours during June if constantly worked at full load. With all

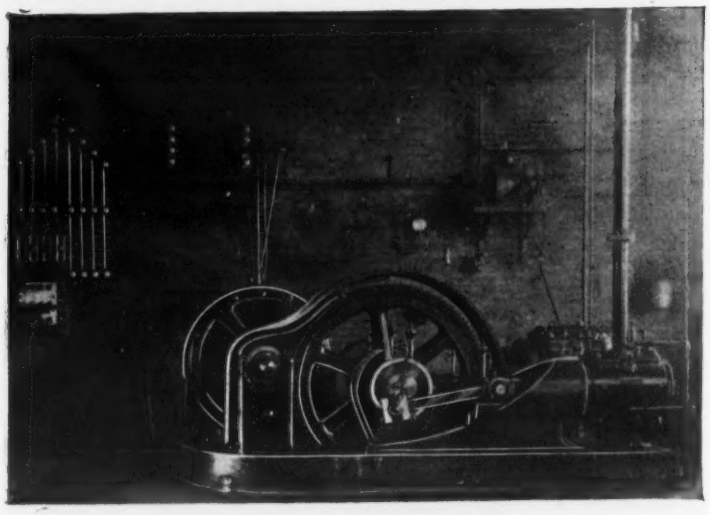


FIG. 4.—MOTOR GEARED TO AIR COMPRESSOR.

motors operating at full capacity during the nominal working time, the energy absorbed by them during the month of June would thus have been 156,860 kw-hours. The actual energy used by these motors during the month being only 57,740 kw-hours, as above stated, it follows that the motors were operated at only 36.9 per cent. of their total rated capacity for the entire number of nominal working hours on an average.

Here, then, is a complete and important illustration of the fact that electric motors in manufacturing plants consume energy at a rate much below their nominal capacities, on an average. The Boston and Maine shops may be taken as fairly typical of the power requirements in metal and wood working plants. It is probable that there are times when the demand for power is equal to the greater part of the normal rating of all the motors. The fact that generators of 300-kw total capacity were installed to operate the motors supports this view. In spite of occasional large demand for power, the motors show, as above, an average consumption of only 36.9 per cent. of the energy necessary to operate them at full capacity during their nominal working hours.

Wireless Telegraphy and Maxwell's Theory.

By Frederick K. Vreeland.

THE mode of propagation of the electric waves employed in wireless telegraphy has been so freely discussed in these columns that one hesitates to prolong the argument. Yet the great diversity of the ideas submitted in explanation of the facts would indicate that the incident is not yet closed, and that the beautiful work of Maxwell and his followers still lacks appreciation. Several of these explanations are reviewed by Mr. A. Frederick Collins in the issue of August 2, and he in turn submits another which is not altogether in accord with the generally accepted views on the subject.

First, as regards the conductivity of sea water. If we accept the prevalent theory that electrolytic conduction is due to the motion of charged material particles or ions, it is quite conceivable that, where the alternations are sufficiently rapid, the inertia of the ions and the influence of neighboring molecules might prevent the ions from responding to the electromotive impulses, and the electrolyte would then become an insulator[1].

Whatever the explanation, it is evident that sea water is quite transparent to light, and even with waves a million times longer, such as are produced by the smaller Hertzian oscillators, it acts as a more or less perfect dielectric; but the waves used in wireless telegraphy, at a frequency of a million cycles per second, are several hundred times longer still, and it is a well established fact[2] that at these frequencies sea water is a good conductor, and hence quite opaque to such waves. So if we are to accept the "free wave" hypothesis we must find a way to get *around* the surface of the ocean, not through it.

Diffraction has been suggested, but we must remember that the amount of deviation depends upon the relation of the wave-length to the sharpness of the diffracting edge. M. Gouy, in his experiments on the diffraction of light by the edge of a very keen razor, obtained remarkable deviations; but here the thickness of the edge was comparable to the wave-length of light. If waves 1,000 feet long could go around the earth we might expect light to pass around a sphere one inch in diameter, whereas the keenest edge obtainable is none too sharp for wide deviations.

Mr. Collins refers to the twilight produced by diffuse reflection when the sun is below the horizon, but the sun's rays are reflected by material particles, large in proportion to the wave-length, and as the diameter of the particles approaches the wave-length the reflection becomes less and less perfect. The longer waves are naturally the first to be affected; hence on a perfectly clear day, when the suspended particles are very minute, the sky takes on its characteristic blue color due to the preponderance of the shorter waves.

Where are the material bodies in the upper air large enough to reflect waves 1000 feet long? Clouds will not do, for Marconi and others find a fog-bank quite transparent. Some think that the rarified upper strata of the air are sufficiently good conductors to reflect the waves, but this remains to be proved, and the idea has not gained general credence. However this may be, the fact remains that transmission by free waves has not been successful over long distances. Marconi and many others have tried it faithfully, using parabolic reflectors and other concentrating devices; but not until the grounded antenna was adopted did long distance signalling become possible.

What, then, is the real nature of the radiations?

To gain a proper understanding of the subject we must go back to the fundamental conceptions of Maxwell. His beautiful theory, the masterpiece of a master mind, conceived and developed twenty-five years before Hertz observed the first electric waves in space, has been expanded and amplified by such men as Heaviside, J. J. Thomson, and Poincaré until it gives a complete explanation, not only of

[1] See E. Cohn, Wied. Ann. 38, p. 217.
[2] See J. J. Thomson, Proc. Roy. Soc. 45, p. 269.

the subject we are now considering, but of nearly all the intricate phenomena of light as well. Such a complete corroboration of the theory is sufficient proof of the hypotheses on which it is based, and these principles are so important and far-reaching that we cannot afford to overlook them in this connection.

Imagine a condenser, composed of two plates of metal separated by an air space, and connected by a loop of wire containing a battery (Fig. 1). The moment the battery is put in circuit a current begins to flow, and continues until the condenser is charged to the potential of the battery. We would say, in the language of the old theory, that the current flows from the battery to the condenser, and there, being checked by the layer of insulating air, it spreads out over the surface of the plates, and stops. But Faraday discovered that if instead of air he placed a block of paraffin or glass between the plates, a much greater integral current would flow before the condition of equilibrium was reached. If the dielectric layer were simply an inert insulator, all dielectrics should behave alike; but this experiment shows that some electrical action must take place within the mass of the dielectric itself. But what is its nature?

Maxwell says *it is an electric current.* The current does not stop at the surface of the plates, but continues to flow through the dielectric, with this difference, however: When a current flows in a conductor, it encounters an ohmic resistance, which is analogous to friction, in that it continues unchanged in magnitude as long as the current flows, and the energy absorbed is converted into heat. In a dielectric, however, the reaction is of an elastic nature; it is as if the current had to compress a multitude of tiny springs, whose tension increases continuously as long as the current flows; until finally the elastic reaction equals the direct e. m. f. and the current ceases. The energy expended in overcoming this reaction is not converted into heat and dissipated, but is stored in the dielectric, and may be liberated again in the form of an electric current in the reverse direction as soon as the tension is removed and the "springs" are allowed to unbend.

The current which flows in a dielectric is thus a "displacement current." The elastic reaction or "electric force" is proportional to the degree of the displacement in the dielectric, and the direction of this displacement, if plotted continuously, gives the familiar system of "lines of electric force." Hence, according to Maxwell, there is no such thing as an "unclosed current"; but the circuit is always completed, as a conduction current in conductors, and as a displacement current in dielectrics.

Again, consider a straight wire carrying a current. If we explore the field surrounding the wire with a compass needle we find it to be permeated by a magnetic force which may be plotted as a system of closed circles, the "lines of magnetic force," surrounding the wire. This magnetic field, like the electrostatic field considered above, represents an accumulation of energy; but whereas the latter was a form of potential energy, due to the strained condition of the dielectric, this is kinetic energy, which Maxwell supposed to be due to the motion of the dielectric, or of the ether which permeates it. The self-induction of a circuit, which opposes an increasing current and assists a decreasing one, is due to the inertia of this moving medium which surrounds it.

This magnetic force, and the electric force considered above, are interconnected by well-known laws, which we may not discuss here[3]; but let us consider briefly what takes place when an oscillator is set in operation.

Take, for simplicity, a straight wire, interrupted in the middle by a spark gap. Suppose the two knobs which constitute the spark gap to be suddenly connected to a source of constant high potential, not quite sufficient to break down the air gap. A current flows from the knobs towards the ends of the apparatus, and continues until both conductors are completely "charged." While this is taking place, displacement currents are flowing back through the dielectric until, when the condition of equilibrium is reached, the whole surroundng medium is in a state of electrostatic stress which may be expressed by a system of lines of force such as is shown by iron filings around a bar magnet. (Fig. 2.) These lines, it should be remembered, show the direction of the electrical displacement in the medium.

Now suppose the air gap to break down. A current surges across the gap, the stress in the dielectric is relieved, and displacement currents begin to flow back along the lines of force.

It is well-known that a variable current in a conductor induces similar currents in neighboring parallel conductors. So also in the dielectric; the displacement currents suddenly set up by the discharge of the oscillator induce similar displacement currents in the adjoining portions of the dielectric, and so the disturbance is propagated outward from place to place in an ever-expanding wave.

At the moment when the conductors are completely discharged and the current flowing across the spark-gap is a maximum, the energy of the oscillation is entirely kinetic, *i. e.*, magnetic, and no lines of electric force proceed from the oscillator. As the conductors become charged again with the opposite polarities, this changes into potential energy, stored in the strained dielectrics, about the oscillator. And these alternations of potential and kinetic energy are transmitted outward in somewhat the same way as sound is transmitted from a vibrating tuning-fork—here a layer of moving air under normal pressure, next a layer of compressed air without motion, and so on; only in the case of electric waves the direction

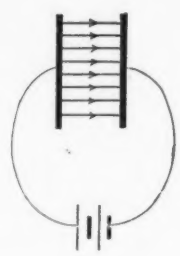


FIG. 1.—CONDENSER.

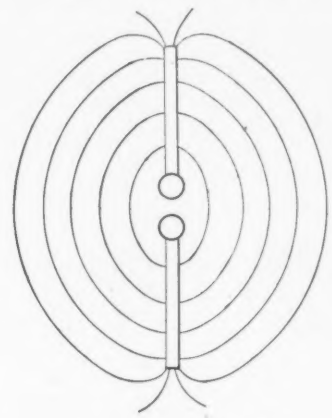


FIG. 2.—SPARK-GAP.

of the current and of the stress which alternates with it is perpendicular to the line of propagation, while in sound the action is in the direction of propagation. Indeed, the action in the ether may be compared to the motion of a series of incompressible plates, capable of sliding over each other, but bound together by an elastic connection which tends to make them slide back to the position of equilibrium after being displaced.

The form of the wave which proceeds from the oscillator has been worked out by Hertz[4], and more fully by J. J. Thomson in his supplement to Maxwell, but as the pith of the matter has been given by Mr. Lee De Forest in your columns of May 17, 1902, it is not necessary to repeat it here. His Fig. 3 (p. 859) shows the lines of electrical displacement at the moment when the two conductors are fully charged and the current is about to reverse; the closed loops at the right and left represent a wave that has detached itself from the oscillator and is beginning its outward journey. As the wave travels outward the loops expand vertically until at last we have practically a spherical wave front, and the lines of force are circles (at least in the equatorial region) whose common center is at the oscillator. The direction of propagation being perpendicular to the wave-front, the disturbance travels radially in straight lines, like light.

These are free waves in space, the peculiar discovery of Hertz. They show the phenomena of reflection, refraction, diffraction, polarization, total reflection, double refraction, etc.; indeed, when allowance is made for their long period and rapid damping, with long intervals of rest, they are quite the equivalent of polarized light.

When such a wave encounters a conducting body, the displacement currents in the dielectric induce conduction currents in the conductor, and these currents in their turn become a source of

[3] This relation for free ether is expressed by Maxwell's fundamental equations:

$$A\frac{dL}{dt} = \frac{dZ}{dy} - \frac{dY}{dz} \qquad A\frac{dX}{dt} = \frac{dM}{dz} - \frac{dN}{dy}$$

$$A\frac{dM}{dt} = \frac{dX}{dz} - \frac{dZ}{dx} \qquad A\frac{dY}{dt} = \frac{dN}{dx} - \frac{dL}{dz}$$

$$A\frac{dN}{dt} = \frac{dY}{dx} - \frac{dX}{dy} \qquad A\frac{dZ}{dt} = \frac{dL}{dy} - \frac{dM}{dx}$$

Where L, M, N, are the components of the magnetic force and X, Y, Z of the electric force at the point whose co-ordinates are x, y, z, and A the reciprocal of the velocity of light.

[4] "Electric Waves," trans. by D. E. Jones, pp. 144 et seq.

radiations—in other words, the wave is *reflected,* though leaving behind a part of its energy which is absorbed by the ohimc resistance of the conductor. Thus we see how conducting bodies intercept the waves, while non-conductors are transparent.

Now suppose the whole system to be divided into two symmetrical halves by an infinite sheet of conducting material passing through the center of the oscillator. All the lines of electrical force are perpendicular to this plane, so no currents are induced in it; the displacement currents complete their circuits as before, following the lines of force; indeed, everything goes on precisely as if it were not there.

Now let the lower half of the system be removed. The middle point of the oscillator was always a point of zero potential, at which the current simply surged back and forth. Now this point is grounded in a conductor of infinite capacity, and the currents from the remaining half of the oscillator surge in and out as before, losing themselves in the perfect conductor.

An acoustic analogy will illustrate. In a sonorous tube, closed at both ends, a disturbance started at one end is reflected at the other, returns to the starting point, is again reflected, etc. These reflected waves interfere with each other and the resultant is a standing wave, with nodes at each end, where the pressure varies but there is no motion; and with an antinode at the middle, where the air rushes back and forth with no variation of pressure. The wave-length is twice the length of the tube. If now we cut the tube in the middle, each half will vibrate as before, like an organ pipe, with a node at the closed end and antinode at the open one; the air rushing in and out of the open end. The wave length will be the same as before, *i. e.,* four times the length of the open tube.

The action of our oscillator with a single vertical antenna grounded in a conducting plane is quite similar, and the wave length is four times the length of the antenna. The displacement currents, instead of making their wide circuits through the air from end to end of the oscillator, now pass into the conducting plane, and the circuit is thus completed. So also with the waves that have detached themselves from the oscillator; the lines of force, which must terminate in opposite electrical charges, find these charges in the conducting plane; and the motion of the charges as the wave advances constitutes a series of conduction currents which complete the circuits of the displacement currents in the dielectric. Thus the half wave travels outward over the plane, precisely as if the other half were present.

Now suppose the conducting sheet to be curved. A perfect conductor is, by definition, one in which only vanishingly small electric forces can exist. Hence there can be no tangential component of the electric force, and the lines of force must always be perpendicular to the surface. If then the surface be curved, the lines of force must accommodate themselves to the curvature, and the wave, whose direction of propagation is perpendicular to the lines of force, will follow the surface.

Thus we see how the waves can follow the surface of the sea. Only in this case, the water is not a perfect conductor and the lines of force are somewhat distorted, the tangential component wasting itself in ohmic losses in the conductor.

Many of the perplexing questions in connection with wireless telegraphy now resolve themselves: The greater facility of transmission over sea than over land; the poor transmission over dry, sandy or frozen ground; the passing of the waves through or over hills while city buildings cut them off; the failure of symmetrical ungrounded oscillators; the value of high antennæ, etc., etc.

We also see that there is a measure of harmony in the various conflicting theories that have been proposed, for the radiators *are* "sliding waves" following the surface of the earth, but they are of essentially the same nature as "free waves in space," and they are accompanied by "oscillating currents" in the earth. So Maxwell's theory affords a meeting ground for the opposing parties in the dispute, and gives to each a firm scientific basis from which to work up his own ideas; for it is not the least remarkable feature of Maxwell's work that it is independent of any particular hypothesis regarding the ether. He makes no assumptions as to the nature of electricity or the character of the disturbances in the ether. Indeed we must guard against putting a too literal interpretation on the terms "current," "displacement," etc., which are only convenient words borrowed from the mechanics of ponderable matter to describe analogous actions in the ether. He simply formulates the laws which govern these actions and leaves to future investigators the task of determining their real nature.

The Alternating Current Arc.

By C. H. Bedell.

RECENT articles on the alternating-current arc have brought out prominently that it has characteristics peculiarly its own, and to those already described should be added the very interesting behavior of this arc when in a magnetic field.

It is well known that any arc may be "blown out" by the approach of the poles of a magnet. The term "blown out," while it correctly describes the action, if the magnet be of the horseshoe type, does not do so if a bar magnet is used, for the arc is then forced out at right angles to the line of the magnet, and not directly away from it,

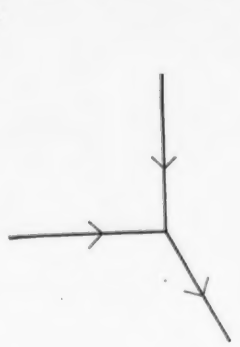


FIG. 1.—DIRECTION OF CURRENT FLOW.

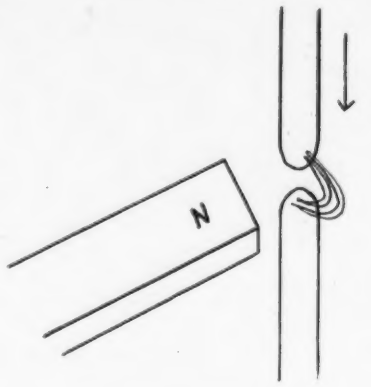


FIG. 2.—THRUST OF ARC TO RIGHT.

as the "blowing out" would lead one to suppose. This forcing to one side of an arc by a magnetic field is due to the same laws which govern the action on wires carrying current on the surface of a motor armature; that is, the direction of flow of the current, that of the lines of magnetic force, and direction of movement are all at right angles to each other, and may be illustrated by the arrows in Fig. 1.

If, therefore, the north pole of a bar magnet be presented to a direct-current arc and the current flows down, the thrust will be to

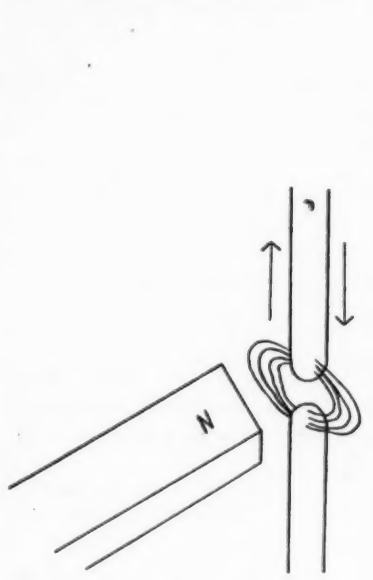


FIG. 3.—ARC WITH TWO WINGS.

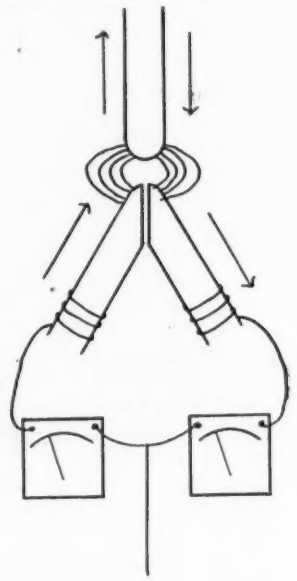


FIG. 4.—DIVISION OF CARBONS.

the right, as in Fig. 2, and if the current flows up the thrust will be to the left. With an alternating-current arc the two above effects are combined, and the arc appears to have two wings, as shown in Fig. 3. Of course, these two wings do not exist at the same time though appearing continuous to the eye, but follow the alternations of the current; that is, when the current flows down, the lines of force from the north pole of the magnet force the arc to the right, and when the current flows up, the thrust is to the left.

This property of the alternating arc in a magnetic field of separating the currents of opposite direction into two paths, furnishes a means of extending the separation, and obtaining in one conductor the portions of the alternating current which flow in one direction, and in another conductor the portions which flow in the opposite

direction. By dividing one of the carbons, as illustrated in Fig. 4 (magnet not shown), wires may be connected to direct-current ammeters which will indicate the presence of direct or pulsating currents. Constructed in this manner, the ammeters will not read until the magnet is presented to the arc. As soon as the arc is divided into the two wings, the instruments read the average current flowing in each circuit, and also indicate that these two portions flow in opposite directions.

If the current curve followed the e. m. f. curve, it might be represented, as in Fig. 5, and after the separation by the magnet, by the two curves, as in Fig. 6, where the current is passing in one wire, when there is zero current in the other. The current curve, however, does not follow the e. m. f. curve, but remains at zero until the e. m. f. of the line equals the counter e. m. f. of the arc. This is shown by Fig. 9, which is from a photograph of an ordinary alternating arc, as seen in a revolving mirror (axis vertical). It will be noticed that the period of darkness nearly equals that of light, showing that the current does not flow until some time after the e. m. f. commences to rise.

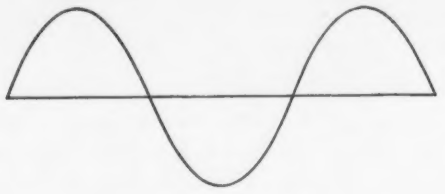


FIG. 5.—CURRENT CURVE.

The appearance of the arc under the influence of the magnet is interesting, as the wings may easily be made to have an extent of five inches from tip to tip, and with an upward curve due to the currents of heated air. An attempt to photograph such an arc was made, and it was found necessary to shield the lens from the strong violet rays of the arc proper, in order that sufficient exposure might be obtained on the wings. This photograph is shown in Fig. 7.

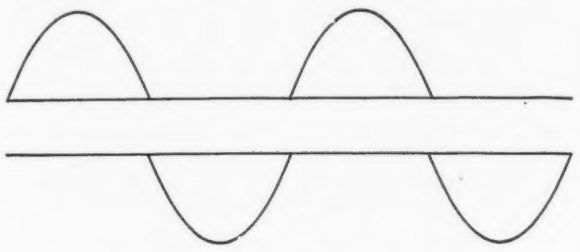
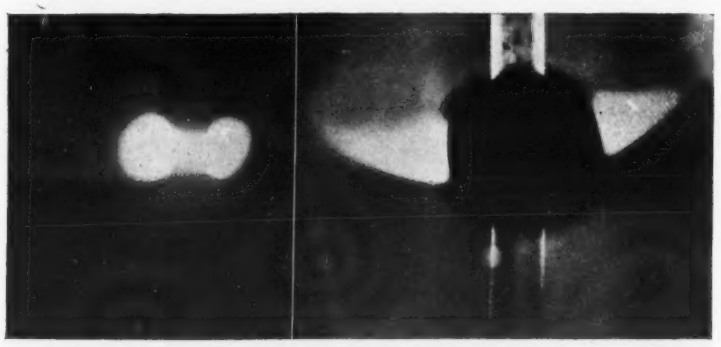


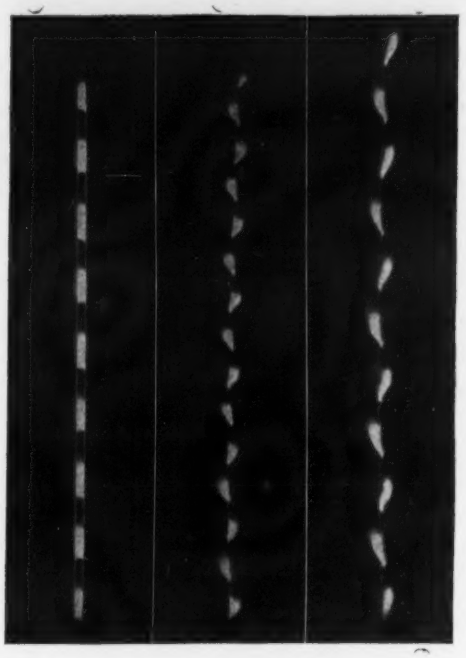
FIG. 6.—CURVES AFTER SEPARATION BY MAGNET.

Fig. 8 is from a photograph of the violet arc proper, extended sideways by the magnet. It will be noticed that the ends of the carbons, although brilliantly incandescent, do not appear to give out many chemical rays. The exposure was made short to suit the violet arc, and, therefore, it would seem that but little violet light was given out by the incandescent ends of the carbons. The question, therefore, arises, is not the curve of illumination for actinic rays for any arc lamp quite different from the curve of illumination for visual rays?



FIGS. 7 AND 8.—PHOTOGRAPHS OF ARC.

Probably the most interesting photographs taken of the alternating arc under the influence of the magnet are those shown in Figs. 10 and 11. These were taken of the arc as seen in a revolving mirror, having its axis horizontal, and show the separation produced by the magnet—the arc from currents in one direction being on one side of the central line, while that from currents in the opposite direction are on the other side of that line.



FIGS. 9, 10 AND 11.—ALTERNATING ARC UNDER INFLUENCE OF MAGNET.

Thanks are due to Prof. Geo. Hoadley and Mr. Arthur Collins for their valuable assistance in making the photographs.

Deterioration of Storage Battery Plates.

By A. L. Marsh.

In a previous article (Electrical World and Engineer, June 7), the possibilities for a light-weight storage battery were discussed. Lightness is an important factor in traction work, but not of such immediate importance as durability.

The greater part of the patents taken out on storage cells of the lead-lead type are based on minor improvements in mechanical construction. These improvements are generally intended to increase the life of the battery rather than to reduce its weight, although some are obviously designed to secure lightness at the expense of life. There is room for improvement in both directions in the lead cell, but the improvements will undoubtedly come from the chemical and physical study of the active materials and electrolyte rather than in a mechanical way.

From the properties of lead with respect to its equivalent weight, lack of rigidity, etc., and from the nature of the reactions of its compounds during charge and discharge, we are justified in the conclusion that attempts at reduction of the weight of lead cells are impractical, but that there is a profitable field of work in attempting to increase the durability of a cell from the chemical side of the problem.

What is wanted is not a battery which will show good results on a laboratory table, with a competent battery man in charge, but one which can successfully withstand the average treatment given it by inexperienced persons, and the necessarily great variations of current output and the constant jarring to which it is subjected in automobile or street-car propulsion.

It is the purpose of this article to bring out the principal defects which tend to shorten the life of a battery of the lead, and also of other types, and finally to suggest lines upon which improvements may be made.

Taking up first the lead-sulphuric acid-lead peroxide type, we find that in actual practice the negative plates, in a well-designed cell, will last during two or three renewals of the positives. To be sure, the negatives gradually lose their capacity, but ordinarily the depreciation is so slow that it is practical to use them with several sets of positives. It has been claimed by a battery man of con-

siderable experience, that a negative plate can be made light and yet last during four or five years of constant service. Since the positive electrode is the weak point of the cell, I shall concern myself more particularly with it.

In discharging a lead storage cell, lead sulphate is formed on either plate. This sulphate being insoluble remains in its position and there is thus formed a mixture of lead peroxide and lead sulphate on the positive electrode, and spongy lead and lead sulphate on the negative. As the proportion of sulphate increases, the conductivity of the mixture decreases. In practice the proportion of the sulphate is not allowed to increase to more than 50 per cent., as at this point the electromotive force of the cell falls (and even before this point is reached), and further sulphation takes place rapidly if the cell is not at once recharged.

It is held by some that this mixture is in reality a complex compound; that the lead peroxide of a charged cell is not as represented by the simple formula PbO_2, but is an allotropic form in which many simple molecules are combined into the complex one $(PbO_2)x$, where x is an unknown number but assumed to be 50 for mere convenience. Then the discharge of the positive electrode will be represented by a series of changes in the molecules, as follows: $(PbO_2)_{50}$, $(PbO_2)_{49}{}^{\circ}$ $PbSO_4$, $(PbO_2)_{48}{}^{\circ}$ $(PbSO_4)_2$, . . . to approximately $(PbO_2)_{25}{}^{\circ}$ $(PbSO_4)_{25}$, when the electrode has practically reached its discharge limit. Each molecule contains some lead peroxide throughout the discharge and keeps the mass conductive. The molecule becomes less stable as the percentage of peroxide decreases, and when the point represented by $(PbO_2)_{25}{}^{\circ}$ $(PbSO_4)_{25}$ is approximately reached, it readily breaks up with the formation of ordinary lead sulphate and simple molecules of lead peroxide, thus accounting for the rapid sulphation which is apt to take place if a cell is allowed to remain long uncharged. This structure of the molecule also accounts for the ease with which the discharged plate is reconverted to the peroxide condition, it being generally held that pure sulphate of lead is very slowly converted to the peroxide electrolytically, and only with a relatively large expenditure of energy.

This theory of the complex nature of the lead peroxide molecule was brought forward by Wade in a paper read before the British Institution of Electrical Engineers.

Theory is a thing to explain facts. Whatever the theory held, the fact remains that sulphate of lead does form rapidly if the cell is allowed to stand uncharged, and also forms under other conditions which are not well understood. Although sulphation can be controlled to a certain extent by exercising great care, it is still a serious drawback to the use of lead in batteries, and is in a large measure responsible for the rapid deterioration of the plates.

Another cause for deterioration is the lack of porosity in the active mass. The plate cannot absorb sufficient acid for its discharge, and so must depend upon diffusion. A heavy discharge will exhaust the acid in the interior of the active mass, and, as was shown by Gladstone and Tribe, the normal reactions do not take place in very dilute acid.

A rapid charge may loosen particles of the active material by the too rapid evolution of gas. This is known as scaling.

In pasted plates the peroxide mass softens when subjected to severe service in an automobile, and tends to wash away from the grid. This result takes place in a very short time if sediment is allowed to accumulate in the bottom of the cell until it touches the lower edges of the plates and thus causes a short-circuit. This sediment, consisting of lead sulphate, is continually forming and necessitates the frequent washing of the battery to avoid harm to the plates.

In order to prevent the falling away of active material, due to the softening of the mass and to dislodgment by escaping gas, and to prevent sediment from falling to the bottom of the cell, some battery makers wrap the plates with some porous substance, as specially treated cellulose, glass, wool, etc. I do not know to what extent this method is alleviating the trouble, but in my opinion it cannot stop the formation of sediment, which I believe is due to the following causes:

Lead sulphate is soluble in concentrated sulphuric acid, is practically insoluble in dilute acid, and is again slightly soluble in pure water. In charging a cell at a fairly rapid rate, sulphuric acid is liberated in the pores of the active masses faster than it can diffuse out. Therefore the interior of the plates must contain fairly concentrated acid, in which lead sulphate is slightly soluble. This strong acid, carrying lead sulphate, slowly diffuses out of the plates and is there diluted by the weaker acid. The sulphate being less soluble in the weaker acid, is precipitated and settles to the bottom of the cell. This action would take place through the porous envelope and so form a sediment the same as without it.

The way to prevent this action would seem from the foregoing to be by preparing the plates with greater porosity, so that the acid could diffuse more rapidly, and so avoid great changes in density of the electrolyte, or by preventing the formation of the white sulphate, assuming Wade's theory to be correct; preferably by both methods together.

Mr. G. H. Robertson thinks that the formation of sulphate might be checked by adding some substance to the electrolyte that will prevent the formation of oxidized bodies in it, and which at the same time will not injure the plates.

ZINC-COPPER OXIDE CELL.

This cell, which uses an alkaline hydroxide electrolyte, possesses certain advantages over the lead cell, but also introduces new difficulties, which have rendered it less useful than the lead type. In the alkaline cell there is no such thing as sulphating and buckling, and no harm is done to the plates even if charge does not immediately follow the discharge.

The zinc negative, however, is liable to local action, and great difficulty is experienced in plating the zinc in compact form available for the discharge. To charge the cell, the temperature should be about 54° Centrigrade, and the charge rate low and intermittent to produce the best results. These conditions cannot always be realized in practice, and since the life of the cell is rather short and its application somewhat limited, owing to the comparatively short time that it will retain its charge, this type has not been able to fulfil the expectations of its promoters.

NICKEL-IRON CELL.

The nickel-iron cell, invented by Mr. Edison, I think will be found subject to certain bad tendencies similar to those of the lead cell, but they may be found less difficult to control.

The material of the positive electrode is peroxide of nickel, probably having the formula NiO_2. In the discharge of the cell, the peroxide is reduced, according to one theory, to nickelous oxide (NiO). This compound (NiO) is difficult to oxidize electrolytically, while a reduced peroxide plate is not.

It seems likely that the reaction of discharge is in many respects analogous to that of lead peroxide, and that the capacity is only about half of the theoretical. In normal discharge, I believe that the lowest oxide formed is the sesquioxide Ni_2O_3 (sometimes called peroxide), but under certain conditions the nickelous oxide (NiO) might be formed, and would present difficulties similar to those due to the formation of lead sulphate in the lead cell were it not for the fact that the oxide is insoluble, so that it remains in place and is slowly brought back to the proper condition.

Overcharging does not harm the plates, because nickel is not readily attacked by the nascent oxygen if the electrolyte is a solution of pure potassium hydroxide. Chlorides, nitrates and tartrates should not be present, as nickel is more readily attacked in such solutions.

ZINC-CHLORINE CELL.

Cells of the zinc-chlorine type, with a carbon plate for the positive electrode, have the disadvantages of difficulty in obtaining good deposits of zinc, high internal resistance and difficulty of handling the gas. Cells of this type will probably not enter into competition with lead accumulators.

SILVER CELL.

Of all the storage cells having insoluble electrodes, those using silver oxide for the positive seem to be best adapted to maintain normal reactions under the severe conditions of service. Jungner uses this material in his work with storage cells.

As was mentioned earlier in this article, the negative plate of a lead cell is very durable when compared with the peroxide plate. The difference must be due to the metallic nature of the negative. In the discharge, only about half of the spongy lead is converted to the sulphate, so there is always some metal present and this is in the nature of sponge which holds the mass together. By obtaining a similar physical condition on the positive there should be realized an increase in the life of the battery, corresponding approximately to that of the negative electrode.

To obtain this condition, a depolarizer which reduces to the metallic state must be chosen and, moreover, this metal must have

the property of holding together when in a spongy state. Silver oxide is such a material.

Taking a silver-cadmium cell for illustration, we have spongy cadmium and silver oxide when the cell is in the charged state, and cadmium oxide and spongy silver when in the discharged state. In both these plates we have a condition very similar to that of a spongy lead electrode. There is this difference, the silver passes from an oxidized state to approximately half oxide and half meallic and half negative plates pass from the metallic state to half metallic and half oxide or sulphate, as the case may be. The positive is never entirely reduced, and the negative never entirely oxidized under normal conditions, but they are near enough alike so that we should expect them to be of approximately the same durability.

Silver presents the difficulty that its oxides are slightly soluble in the alkaline electrolyte in which they are used. It has a great advantage, however, in the nature of its reactions. A cell may be left in any state of charge, or completely discharged, without danger of harming the plates. There is no tendency to form compounds which cannot be brought back to the original charged state with ease. Spongy silver can be readily oxidized to the oxide (Ag_2O), or to the peroxide (AgO), and the oxide (Ag_2O) may be easily further oxidized or reduced. No other compounds are formed. Silver oxide may be made by chemical methods and applied to the electrode which can then be used immediately without any forming process. This is a good indication that the chemical reactions will not get out of order as long as they are confined to the electrode.

The slight solubility of silver oxide is the weak point in this cell, but this drawback can perhaps be largely overcome either by a method employed by Mr. Edison in the preparation of copper electrodes or by slight alterations in the electrolyte.

CONCLUSION.

The lead cell has not received enough attention from its chemical and physical side, most manufacturers having paid more attention to mechanical details, and this has given the battery a rather unbalanced development. However, the manufacturers are now giving more attention to the chemistry of batteries, and we may expect to see in the near future a considerable improvement in lead cells in the way of longer life and greater reliability.

I think the investigations should be directed to methods for securing greater porosity and firmness in the active material of the positive electrode and to improving the electrolyte so as to prevent the formation of lead sulphate, or at least to render it insoluble in all densities of the acid solution, so that it remains in place and can be restored to the proper condition.

Other metals will undoubtedly come into competition with, and may displace, lead in batteries for traction work, but as an auxiliary in electric light and power stations lead cells will probably hold their own for some time.

Nickel is a strong metal compared with lead. Its peroxide belongs to that class of depolarizers which adds electromotive force to the cell, and in this respect it is the best, so far, that it is practical to use in alkaline electrolytes. The electrolyte permits the use of steel for the grids and the containing vessel, and this gives a construction both light and strong. There seems to be no reason to believe that this cell will not do what Mr. Edison claims for it.

Silver would be a good metal to use in traction batteries if its cost were not so great. To be sure, the silver in a worn-out battery would go a long way toward paying for a new set, but the first cost would be rather great. Silver is a rather abundant metal, and ought to be produced for much less than it brings at present, if the demand for it should sufficiently increase.

In the lead cell the active material of the positive is only about half of the weight of the entire plate, so the weight of silver oxide required in the silver cell would correspond to the weight of lead peroxide, and not to the whole electrode. The other materials used would be inexpensive; nickel or steel for the positive grid, and probably iron for both negative grid and active material.

Experiments indicate that a silver battery, giving the same power as a lead automobile battery weighing about 550 pounds, would require only about 70 pounds of silver oxide, and perhaps less. It would not take a very extraordinary reduction in the price of silver nitrate to make the cell practical from a financial standpoint, and for the reasons given above such a cell could be made to have a comparatively long life and high efficiency, and would require but little attention to keep it in working order.

Electrogalvanizing.

By C. F. Burgess and Carl Hambuechen.

THE problems arising in the employment of iron as a structural material have been among the most important with which engineers have had to deal. Of hardly secondary importance, however, is the question of preservation, and this being realized to a greater and greater extent, engineers are devoting more attention to the matter of preventing or reducing the corrosion of iron structures.

Zinc is one of the most effective and most extensively employed commercial agents for limiting this corrosion, and while its use has been extensive for more than a century, it has not reached its highest degree of efficiency. Recent years have witnessed an improvement in the application of zinc for this purpose in employing electricity as a means of applying the protective coating.

The electrolytic deposition of zinc, while rapidly increasing in importance has not as yet replaced to any considerable extent the hot galvanizing process, though if the present rate of improvement in its application continues it will not be long before the older process will be largely superseded.

The difficulties encountered in hot galvanizing can be avoided or reduced by the employment of the electrolytic method, and the overcoming of the new difficulties thereby introduced has been the field of such successful research during recent years that the older processes now have a formidable rival.

The term galvanizing in its usual significance applies to the dipping of iron or other metal into a bath of molten zinc under such conditions that on withdrawal the article retains a thin adherent coating of metallic zinc. The term implies an electrical meaning, and the reason for using this term is variously stated. One of such statements in that the zinc coatings were originally applied by electro or galvanic deposition, and hence the application of this term to all zinc coatings. This is erroneous, however, inasmuch as electrogalvanizing is of comparatively recent origin. The implication of the use of electricity lies not in the method of applying the coating, but rather in the method by which the coating protects iron or other more electronegative elements from corrosion. This is illustrated in Sir Humphrey Davy's successful attempts, over a century ago, to prevent corrosion of iron and copper immersed in sea water by attaching strips of zinc at frequent intervals to the other metal. The protection is offered by the galvanic action which is set up between the zinc and the other metal, whereby current travels from the zinc to the solution, thence to the electronegative metal and back to the zinc. The flow of current from the solution to the metal prevents the corrosion of this metal, although at the expense of an equivalent amount of zinc. Zinc offers protection to iron by reason of the property of the metal in partially excluding the corroding influences of the atmosphere or of various solutions, but more especially utilizing the galvanic effect, as previously explained, and as further illustrated by the employment of the metallic zinc blocks placed in contact with the iron of steam boilers to prevent corrosion.

Zinc being more electropositive than iron, the natural inference would seem to be that it would become quickly dissolved and thus expose the iron, but this is prevented by the formation of an oxide, carbonate, or basic zinc compound, which in many cases completely coats the zinc and thus protects it from corrosion. Zinc has been aptly defined as a substance which in contact with air and moisture effectively paints itself with a protective layer. Any solution, such as various acids, which is a good solvent for such coating, naturally destroys this property.

Where the zinc forms an absolutely continuous layer over the metal to be protected the galvanic property is not utilized, but this is a condition very difficult to attain. To all appearances a coating may be continuous, but microscopical examination will reveal the fact that there is some porosity, which will allow the corroding influences to reach the iron. The electropositive property of the zinc, however, prevents such corrosion and is the cause of its superiority to other metals such as tin, lead, and nickel, sometimes employed for the same purpose. In the latter cases the porosity of the coating is shown by the rust spots which accumulate on the plated article exposed to influences such as salt water and air. The distance to which zinc will protect iron from corroding action depends upon the electrolyte which is present, and it is usually of some considerable value.

The term "galvanized iron" usually implies a product obtained by

dipping iron, in sheet or other form, which has previously been freed from scale and other foreign substances into a bath of molten zinc. A suitable flux, such as salammoniac, is used to facilitate the flow and adherence of the zinc. The iron is left in the bath long enough to reach the proper temperature, when it is removed and made readily for the market. The containing vessel is iron, usually of sheet iron with riveted or welded joints.

The following are some of the disadvantages of this process which the electrical process reduces or avoids. A considerable expense is involved in keeping the large quantity of zinc necessary in a molten condition, heat being lost by radiation from the surface and the sides of the tanks, not only when the bath is in operation but also while standing over night, and by heating up all the iron introduced in the tank to something near the temperature of melted zinc, about 430° C. This heating of the immersed iron is often disadvantageous in reducing the strength and distorting iron and steel of small sections. The maintaining of the metal at the proper temperature causes a loss of zinc by oxidation, and the alloy formed with the iron of the tank not only entails a consumption of zinc but results in the ultimate destruction of the tanks. The depreciation on such vessels may be estimated at from 50 per cent. to 100 per cent. per year. Loss of flux is another appreciable item of expense. Perhaps most important is the fact that the galvanizer has little control over the thickness of the deposits, which causes a waste of zinc in some cases and an insufficient amount in others.

The characteristics of electrogalvanizing may be summed up as follows:

Electrolytically deposited zinc forms a very uniform and dense coating on the surface, more uniform than is possible by the dipping process. The degree of protection offered by zinc is proportional to the thickness of the thinnest part of the coating, and consequently electrogalvanizing enables greater protection to be obtained with a given amount of zinc than does the hot process. Further, electrolytically deposited zinc may be made more adherent and dense than by the older method, still further increasing the durability. The greater purity of electrolytic zinc, together with its greater density, gives it for equal thickness of coating an efficiency in resisting corrosion of 50 to 100 per cent. greater than that of the hot process.

Electrogalvanizing gives to the operator a control through a very considerable range of thickness of the coating which it is desired to apply. It is possible to obtain a much thicker coating by this method than by the older process, where the thickness is regulated to a slight extent only by the temperature at which the dipping takes place. If the melted zinc is kept at a very high temperature and the article to be galvanized is immersed a sufficiently long time to attain the temperature of the bath, the coating may be thinner than when the process is worked at a lower temperature. The physical character of the coating may, however, be seriously interfered with if the process is conducted at too low a temperature.

Many articles which it would be impossible to submit to the hot process may be readily galvanized cold, especially such tempered articles as would be damaged by the heat. Springs may thus be galvanized and perfectly retain their elasticity.

Grooves or lines on metal surfaces are not obliterated by the electrolytic method as they are by dipping, and this is an important feature in certain artistic work and in the preservation of stamps, numbers, markings, graduations, etc. This property shows a very distinct difference between the two methods of galvanizing, the one tending to fill up and obliterate the surface irregularities or markings, and the other preserving or even accentuating them. In some cases this difference would be a disadvantage rather than an advantage for the electrical method, inasmuch as the former enables a smooth surface to be obtained upon iron or steel which shows the markings or scratches from grinding and filing.

Screws and fittings dipped in the molten metal usually require recutting, while if proper allowance be made for the thickness of electrolytically deposited metal no such extra labor is involved. In certain classes of work such as the galvanizing of iron insulator fittings the pieces may have to be carefully examined for the removal of any knobs or projections which are detrimental to the insulation while in the electrical process this labor is needless.

Advantage has been claimed for both processes as regards adherence of the coating. Suffice it to say, however, that zinc properly deposited by electrical methods upon a suitably prepared surface can be made to adhere as well as it is possible to make any metal adhere, the joining surface seeming to be a real alloy of iron and the zinc. Improper working of either process will result in improper adherence. The cold process is always ready for working, no time being necessary for the heating or cooling of the liquid, and idleness of the solution does not entail the expense that idleness of the molten zinc involves. The fact that the article to be galvanized does not need to be heated enables soldered parts or low melting metals to be treated.

As far as the economy of zinc is concerned, the advantage lies very decidedly with the cold process inasmuch as nearly 100 per cent. of the zinc employed can be deposited in suitable form, while it has been estimated that 20 per cent. of the spelter put into the bath is wasted in the form of oxide or iron alloy.

The much slower rate at which zinc is deposited electrolytically make the size of the plant greater than for the dipping process, and the first cost is, therefore, greater. It should be noted, however, that the cost of one cubic foot of electrolytic bath is only a small fraction of that of the galvanizing bath. One cubic foot of zinc, weighing 400 lbs., has a value of about $20, while one cubic foot of electrolyte can be supplied for 50 cents or less, and the cost of the zinc anodes to supply the metal to the solution may be estimated at from one to two dollars per cubic foot of solution.

The cost of electrical energy is more than compensated for by the saving in fuel necessary to keep zinc molten. The amount of labor and skill necessary is approximately the same for either process. In the matter of cleaning and preparing the surface to be galvanized, the advantage lies with the hot process, for any small spots which might remain after cleaning may become bridged over in dipping, while they will be more likely to show after the electroplating process. This is not as much of an advantage as might appear at first sight, inasmuch as it is a means of concealing rather than preventing defective work. As to the cost of materials, such as toning salts for keeping the solution in proper working condition, the amount is not greater than the cost of flux necessary in the other process. The zinc to be supplied to the galvanizing tanks is of a purer form, and costing perhaps two cents per pound more than the spelter used in dipping, but this results in a pure form of zinc coating. In the sulphate solutions usually employed, lead, which is the common impurity of commercial zinc, is insoluble, and the coating is consequently free from this substance.

The commercial processes by which electrogalvanizing is now being performed may be subdivided into two classes, according to whether use is made of *soluble* or *insoluble* anodes. The former is used almost exclusively in this country, and the latter in England. The well-known Cowper-Coles process employs a lead anode, which is practically unattacked by the sulphate solution which constitutes the electrolyte. The effect of using such an anode is to cause a continual change in the composition of the solution, free acid being liberated in direct proportion to the amount of zinc deposited. The objection frequently raised against the use of soluble anodes is that while theoretically such anodes should keep the bath at constant composition, which is very desirable, in practice such constancy cannot be maintained for reasons which will be discussed later. The use of insoluble anodes introduces a much more rapid change in composition, but a change which is easily taken care of by a circulation of the solution at such a rate that the percentage of the acidity is limited to a suitable value. The acidity of the solution which is drawn from the tanks is neutralized by bringing it into contact with finely divided zinc in contact with coke, the zinc being usually in the form of zinc dust. This zinc sulphate and the solution thus neutralized and regenerated is again ready for use. By proper circulation and operation of the solution, it is claimed that by this process most excellent results are attained.

The action taking place at the lead anode results in the liberation of SO_4 radical which unites with the water forming sulphuric acid and liberating oxygen, which in turn oxidizes the surface of the plate to lead peroxide. This, when formed to a certain thickness, prevents further action of the lead plate, and thus makes it very durable. The condition of the lead anode is practically the same as that of the positive plate of a lead storage cell when fully charged. This discharge potential at such anode during its operation is above two volts in opposition to the flow of current.

Measurements of single or discharge potentials were made at the electrodes of a commercial zinc plating solution under practical working conditions. The measurements were made by means of the normal electrode, mercury and mercurous chloride in contact with a normal solution of potassium chloride, the value of which is assumed to be —.56 volt. In the notation here used, the — sign is

attached to the single potentials in which the tendency is for the current to flow from the electrolyte to the electrode, and the + sign when the tendency is for current to flow from the electrode to the electrolyte.

Fig. 1 illustrates the condition existing when a lead anode is used in a zinc sulphate and aluminum sulphate solution, with a current density of about 15 amperes per square foot.

The applied pressure, E, which is necessary to cause the current I to flow is made up as follows;

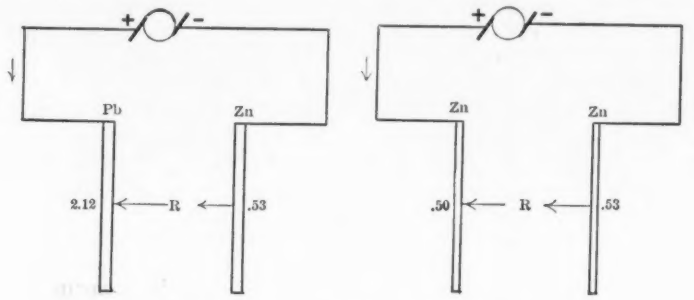
$$E = 2.12 + .53 + I\,R + I\,R_1,$$

where R is the resistance of the electrolyte and R_1 is the resistance of the electrodes and conductors. In this case it is seen that the counter electromotive force to be overcome is 2.65 volts.

Fig. 2 represents conditions when the lead anode is replaced by zinc, and where $E = .53 - .50 + I\,R + I\,R_1$. The counter pressure to be overcome in this case is only .03 volts, due probably to the difference of concentration of solution at the two electrodes.

The reason for desiring to use the soluble anode is that circulation and regeneration of the electrolyte is unnecessary, and the employment of auxiliary apparatus is done away with to a considerable extent. Further, but less important, the amount of power which is necessary is very much less with a soluble anode, as previously shown. In other words, the zinc supplied to the solution in the former case wastes its energy, while in the latter case its potential energy is changed into electrical energy to aid the dynamo.

There are two reasons why zinc anodes do not give the satisfactory results which might be expected. From analogy with the copper anodes used in copper refining, which dissolve away at a steady and uniform rate, zinc might be expected to act equally well, or possibly even better, by reason of the fact that it is a more electro-



FIGS. 1 AND 2.—ELECTROGALVANIZING.

positive element than copper, and consequently ought to go into solution more readily. During the operation of the zinc anodes, even those having a considerable degree of purity, there forms upon the surface of the zinc a scale or coating, usually black in color, which interferes with the solution of the zinc, and increases the resistance to the flow of current. This scale may be caused by the formation of a basic coating, especially if insufficient acid be present, but the principal cause is probably the presence of lead or other impurities which are found to an appreciable percentage in commercial zinc, and which remains undissolved by the action of the current.

The formation of this scale not only has the disadvantage of increasing the resistance and preventing uniform corrosion, but the scale becoming detached in large and small particles may by coming in contact with the cathode interfere seriously with the physical character of the deposited metal.

Another disadvantage in the use of zinc for anodes is that for satisfactory operation the solution must be kept at a certain degree of acidity. While the solution is not in operation this acidity will be neutralized by the zinc uniting with the acid by simple chemical action, and makes necessary the continual addition of free acid, which is subsequently changed to zinc sulphate. This causes a gradual increase in the density of the solution, which, if proceeding beyond a certain amount, produces an unworkable bath, and necessitates the removal of some of the solution and dilution of the remainder. This results in a waste product unless the solution removed be evaporated down and crystallized, which may be a troublesome operation, and gives a product of little or no commercial value, especially if organic substances are used in the operation of the bath.

An ideal process would then be one employing zinc anodes, in which the metal would remain unattacked while current is not flowing, and in which, while current is flowing, zinc will be uniformly corroded without the formation of the previously-mentioned scale. From the results of experimental work, it appears that such conditions may be realized.

The deposition of a good quality of zinc coating depends almost entirely upon the composition of the solution. Unless this is correctly chosen the coating will show the defects of non-adherence, or of spongy, tree, or wart-like character, poor color or pitted surface. The common zinc compounds, the chloride and sulphate, do not give satisfactory deposits when used alone. Of the two, the preference is decidedly with the sulphate, and this forms the basis of most practical zinc solutions. It is found that the coating is improved, as far as color and adherence to the iron is concerned, by the addition of a very small percentage of free sulphuric acid; still this does not prevent formation of rough deposits around the edges. The presence of the acid in the solution further aids in the corrosion of the anode, helping to prevent the formation of the basic salt, and keeping the electrolyte clear, whereas otherwise it would be clouded with a precipitate, which, coming in contact with the cathode, interferes with the quality of the coating.

It is very easy to get an excess of free acid, which would be detrimental in dissolving away the metal as it is deposited, and thus greatly reducing the current efficiency. In fact, with an excess of free acid, it may be impossible to obtain any zinc deposit whatever without the use of abnormally high current density. This is especially the case in depositing on cast iron. What might appear as a peculiarity in the operation of this solution is that with low current densities the current is expended entirely in the liberation of hydrogen, no zinc being deposited. As the current density is increased, the actual amount of hydrogen may decrease until at a sufficiently high density little or no hydrogen is evolved. This is due to the fact that hydrogen having a discharge potential from sulphuric acid of about —.2 volts, is more easily separated out of the solution than is zinc, having a discharge potential of + .5 volts. With low current densities there are sufficient hydrogen ions in the neighborhood of the cathode to take care of all the current. It is evident, however, that with increasing current density there may be insufficient hydrogen ions to take care of all the current, in which case the zinc must play its part and become deposited.

The number of chemical compounds which have been used in connection with zinc sulphate to improve the character of the deposit is very large, as shown by published processes and by solutions which are in operation. Among the most serviceable of such compounds is aluminum sulphate, the presence of which greatly increases the value of the deposit, and when used in the right proportion gives a coating which is entirely satisfactory. No suitable explanation as to why the presence of this substance exerts this beneficial influence has apparently been set forth. A galvanizing process, described quite extensively in the technical papers some time ago, claimed that with an electrolyte consisting of a solution of zinc sulphate and aluminum sulphates, an alloy of zinc and aluminum may be deposited, and the valuable properties of the resulting coating was attributed to the presence of the aluminum. There was probably an error in such conclusions, as no process which has been authenticated has ever been worked out whereby aluminum, either with or without other metals, can be deposited out of an aqueous solution. Further, it is a well-known fact that the presence of aluminum alloyed with zinc produces a metal which is more readily acted upon in solution than the aluminum itself, and such alloy when exposed to water for some length of time becomes brittle and powdery. The writers have made analyses on the deposits obtained from such solutions and they have been unable to find a trace of aluminum present.

To determine if possible to what causes the beneficial action of the aluminum salt in solution can be ascribed, the writers undertook some experimental work, and from the data obtained have arrived at the following conclusions:

It is a well-demonstrated fact that in the electrodeposition of metals for plating purposes, the physical character of the deposit is better in being more compact, uniform and non-crystalline when thrown out of solution by secondary rather than by primary action. That is, a metal deposited by throwing the ions of the metal out of solution directly by the action of the current is not as satisfactory as when some more electropositive ions are liberated, which in turn throw out the metal by a secondary or chemical action. This is illustrated in the ordinary nickel-plating solutions where the NH_4 is the principal electropositive ion which is first liberated directly,

and in turn throws out the nickel by secondary reaction; also in the copper and silver cyanide solutions where the potassium is first liberated, and this in turn throwing out the metal by chemical action.

In the zinc solution under question, the aluminum is the more positive ion, which on liberation reacts with the zinc sulphate to deposit the zinc. While it does not prevent the liberation of zinc by primary action, such zinc is accompanied by metal which is deposited by secondary reaction, and the physical character of the coating or deposit is thus improved. The question might naturally arise as to why aluminum sulphate is more satisfactory than the sulphates of the still more electropositive elements such as potassium and sodium. This is probably due to the fact that the discharge potential from an aluminum sulphate solution is only slightly higher than that of zinc, while that of solution or potassium is very much higher; consequently the sodium or potassium ions would not begin to take part in the reaction unless the current density be extremely high or the amount of zinc very low. It seems desirable, therefore, to choose a substance such that its cathode discharge potential shall be higher, although somewhat near that of zinc, which qualification aluminum sulphate fulfils quite desirably. Measurements which have been made show that the discharge potential at the cathode of zinc from a sulphate solution is very near + .5 of a volt. The discharge potential of aluminum from the sulphate is somewhere around + .59 of a volt. The cathode discharge potential of sodium and potassium is between .9 and 1.1 volts, depending upon current density and character of the cathode. These figures show, therefore, quantitatively why aluminum sulphate is a better substance to use than are potassium or sodium sulphates.

Alum, which is a double sulphate of aluminum and sodium or potassium, is very frequently used in plating solutions, and its value lies in its being a cheap source of aluminum sulphate. The presence of the sodium or potassium sulphate is not harmful, inasmuch as it is not decomposed by the current, and it may even be advantageous in reducing the ohmic resistance of the solution. Measurements showed that the discharge potential of NH_4 is about + .7 of a volt, somewhat higher than aluminum. This is not so high, however, as to prevent it from taking part in the electrolysis along with zinc, using reasonable current densities, and this fact accounts for the use of ammonium sulphate in place of or along with aluminum sulphate in increasing the value of the zinc coating. In fact, solutions consisting of zinc ammonia sulphates have been advertised as giving satisfactory results, and the writers have found that such solutions will give good deposits, although not such as can be obtained with aluminum sulphate.

The chemical action of the aluminum ions which takes part in the carrying of the current to the cathode is as follows:

$$2\,Al + 3ZnSO_4 = Al_2(SO_4)_3 + 3Zn.$$

This is the reaction which takes place in the main, but the deposited aluminum also may unite with the water to a small extent in accordance with the following equation:

$$2\,Al + 6H_2O = Al_2(OH)_6 + 6H.$$

The aluminum hydroxide which is thus formed is a precipitate, insoluble in the solution unless free sulphuric acid be present, forming with it aluminum sulphate. The presence of this precipitate which shows itself by a cloudiness of the solution is detrimental to a good deposit, inasmuch as particles may attach themselves to the cathode and thus destroy its uniformity. A good plating solution must be kept as clear as possible. The presence of a sufficient amount of free acid will prevent such cloudiness, but it is quite evident that under certain circumstances the amount of acid which might thus be necessary might be sufficient to be detrimental in obtaining a deposit of zinc of suitable nature, as previously pointed out. There is a sufficient range, however, in suitably prepared electrolytes to allow such an amount of acid to be used to avoid both difficulties.

An electrogalvanizing process, which has been patented and used extensively in this country, employs certain organic substances as an essential constituent of the solution, together with aluminum and zinc sulphates. Use is here made of the well-known fact that organic acids, such as tartaric acid, and other organic substances, such as glucose or grape sugar, prevent the formation of basic or insoluble precipitates from aqueous solutions of aluminum salts.

Such materials, while being efficient and cheap, have the decided disadvantage of complicating the solution and requiring that the plater shall be something of a chemist to keep it in the best working condition. During the electrolysis this material may become oxidized at the anode, or reduced at the cathode, forming other compounds and necessitating occasional addition of the organic material. There is no convenient way for testing the amount of such organic material present, and the plater must work rather blindly in keeping his solution at the proper composition. Experience has shown this to be a very decided disadvantage, and it frequently happens that if the plater cannot get his solution into working condition by the addition of such organic materials, he is forced to throw away the entire solution and start over with a new one.

The electrodeposition of zinc presents problems which are not noticeable in the deposition of other metals. One such problem is that the structure or the composition of the iron which is to be plated offers marked differences in the ease with which the surface will take a coating. A piece of clean wrought iron may be quickly and evenly covered with little or no evolution of the gas, while an equivalent piece of cast iron using the same current density will receive the coating slowly or not at all, accompanied by a copious evolution of hydrogen. This is especially marked if the cast iron has been cleaned by the pickling acid and then immersed in the plating solution. If, however, the surface be scratch-brushed or ground on an emery wheel after coming from the acid dip, the coating will "take" with less difficulty.

An explanation of this is found in the fact that difficulty is encountered in the deposition of zinc on graphite or carbon from an acidified solution, especially when the latter is in contact with iron. This is contrary to what would naturally be expected, inasmuch as the more electronegative materials are supposed to more readily receive a deposit than those higher up the scale, and the fact that carbon, an element more negative than iron, receives its deposit with great difficulty, is an anomaly, which for explanation requires a further knowledge than appears at the present time available. An experimental demonstration that such phenomenon actually exists was made by drilling holes in cast iron and in wrought iron, filling the same with plugs of graphitized carbon and immersing in the zinc-plating solution. The main portion of the surface quickly took its coating, while the graphite received no deposit for a considerable length of time, and, in fact, protected the iron in the immediate neighborhood of it from receiving a deposit.

When cast iron or iron containing a considerable amount of graphite is cleaned by acid, the graphite is unattacked, and, as the iron is dissolved away, more and more comes to the surface, which thus becomes an iron surface to which are attached innumerable small particles of graphite. Each particle not only refuses to receive a deposit, but protects the iron in this immediate vicinity from receiving it. This shows the necessity of employing some method other than the acid dip alone for preparatory cleaning of cast iron, No practical acid dip will dissolve the graphite as well as the iron, and it must, therefore, be removed by mechanical methods, such as the scratch-brush, grinding, the use of the tumbling barrel or sand blast. It is for this reason that a cast-iron surface prepared by the sand blast receives its deposit most readily. The relatively smaller content of graphite, which wrought iron and steel possess, make them much easier to galvanize than cast iron. An iron casting which has been pickled for a short time will receive a zinc coating more readily than cast iron which has been machined and pickled for some length of time. This may be explained by the fact that the chilled surface of the casting contains a smaller percentage of graphite than does the inner part of the iron.

Although with moderate current density the cast iron will refuse to take this coating, a high-current density applied for a considerable length of time will produce a suitable layer of zinc.

To determine the effect, if any, of materials other than carbon in contact with the iron, plugs of aluminum, amalgamated zinc, lead and copper were driven into cast and wrought iron, and they all, including the aluminum received a deposit quite readily and did not protect the surrounding iron as did the carbon. A possible exception appeared in some cases where the iron around the amalgamated zinc plug received a lighter coating than the iron some distance away. The silicon may have an effect similar to carbon, but this has not been investigated.

An experimental investigation which was made to determine the effect of the presence of graphite, produced some interesting results. The solution used was taken from an ordinary plating tank, and consisted of zinc sulphate and aluminum sulphate dissolved in

water, in which was present a small amount of free sulphuric acid.

By means of single potential or discharge potential measurements made at the cathode, it was shown that + .5 volt was necessary to cause deposition of zinc. The measurements were made by causing current to flow through the cell, and upon the instant of interrupting the current the potential reading was taken. By means of a specially constructed switch this measurement could be made with little error.

If no hydrogen ions were present in the zinc solution, it would require only a low-current density to bring the discharge potential up to the required value, but the free acid furnishing the hydrogen ions makes it necessary to employ current densities of considerable value, the amount depending upon the percentage of acid and to a marked degree upon the material of which the cathode is composed. This fact has been pointed out by Coehn (*Zeitschr. Elektrochem.*, July 13, 1899), and our measurements confirm his conclusions. With equal values of current density the discharge potential of the hydrogen from a dilute sulphuric acid solution was found to be: on zinc, + .47 volt; lead, + .51; copper, + .49, and graphite, + .19.

These figures show that it takes a much larger current density to raise the discharge potential high enough to deposit zinc on graphite than on the metals mentioned, thus giving a quantitative demonstration of the fact that iron in contact with numerous particles of graphite is difficult to plate upon.

A difficulty more noticeable in zinc deposition than in the use of most other metals for plating purposes is the failure of irregular shaped objects to receive a uniform deposit. Bodies which have cavities or recesses, hollow articles, or any, in fact, in which there is a considerable variation in the distance between various parts of the surface and the anode, become coated on the elevated or more exposed parts, and the deposit in the deeper or more removed parts is either very light or entirely absent. In such cases where zinc fails to be deposited a copious evolution of hydrogen may be observed. This is due to the fact that a certain definite cathode current density of a fairly high value is necessary in acidified solutions before zinc deposition ocurs, and while such suitable current density may be flowing on the outer or more exposed surfaces the portions of the surface further away from the anode or protected by the adjacent metal receives too low a current density. The resistance of the solution plays an important part in making this effect more noticeable. The better the conductivity of the solution, the more even is the deposition. As a consequence materials are frequently added to the solution whose sole rôle is to increase the conductivity, such materials not taking part in the electrolytic decomposition.

The shape of the anode is an important factor in electrogalvanizing. It should be designed so as to conform with the shape of the article to be plated, making the distance from the anode to each portion of the cathode as uniform as possible. Sheet plate cathodes require similarly shaped anodes; hollow articles such as pails require the anode to be inside as well as outside; wires are galvanized by passing them through circular anodes. As a general rule the anode current density should be of a lower value than the cathode density.

To increase the depth to which the coatings will strike or adhere and overcome the tendency which the graphite and other foreign materials influence the same factor, recourse is frequently had to what are known as "striking" solutions. By the use of such solutions the body to be plated almost instantly receives a coating which is distributed fairly uniformly over the entire surface, and after such coating has been formed, subsequent deposition may proceed upon two different principles; one of them is the use in the zinc plating solution of a metal salt, the metal of which is more electronegative than the zinc. The most commonly employed and the most satisfactory of such salts is tin chloride, which is added to the solution in small quantities from time to time. The tin which is thus held in solution is deposited with a lower discharge potential than is necessary for zinc, and even for hydrogen, and consequently a low-current density will throw out such metal. This will cause the entire surface to become coated with a layer of tin, striking into cavities quite satisfactorily. The properties of striking solutions are based to a considerable distance, and the subsequent coating by zinc will then take place more readily. The tin being in solution in a very small quantity, the electrolyte in the neighborhood of the cathode becomes exhausted of tin ions, and the zinc ions then become liberated exclusively. The tin layer seems to exert a beneficial action upon the color and appearance of the galvanized surface. The addition of this tin salt, which is necessitated from time to time, costing about 25 cents per pound, is an additional source of expense in electrogalvanizing, and this may be an especial disadvantage in view of the fact that the tin is deposited out not only at the cathode where it is made use of, but also at the anode where it is of no value. The deposition at the anode is caused by the fact that the zinc is much more electropositive than the tin and, therefore, throws out the latter metal by simple immersion. The tin which is thus thrown out accumulates as spongy masses of various sizes, which may sink to the bottom or by reason of the fine degree of subdivision float on the surface. This accumulation of tin is especially noticeable if the anodes are left in the solution while the tank is idle. The tin which is thus thrown out may, of course, be recovered, and by suitable chemical treatment be again changed into soluble salt, but the labor involved in such treatment would hardly result in any saving. It is, of course, evident that if a lead or other insoluble anode be used this abnormal consumption of the tin salt would be reduced. Nitrate of mercury has also been used as a "striking" material, its action being much the same as that of the tin salt. It is quite effective as a means of coating iron, but it has the disadvantage of making the subsequent zinc deposit brittle. Insoluble anodes would here be necessary.

The other principle utilized in the striking solution is the employment of an electrolyte in which the zinc does not exist to any appreciable extent as an electropositive ion, and in which it is, therefore, deposited out entirely by a secondary reaction. In this case the positive ion is a substance more electropositive than the zinc. Such solution is one composed of potassium zinc cyanide. In an experimental investigation by F. J. Newman, in the laboratory of Applied Electrochemistry, at the University of Wisconsin, over a hundred tests were made on solution of various compositions to determine which would give the best results. He found that a solution made up in the following manner w? most satisfactory: Fourtenths of a pound of potassium cyanide is dissolved in one gallon of distilled water, to which is added as much zinc carbonate as will be dissolved. This solution is then filtered and ready for use. A current density of 14 to 25 amperes per square foot produces an excellent deposit, the thickness of which depends to a considerable extent upon the length of time during which the article is left in the solution. The deposit thus obtained is very excellent as far as durability and appearance is concerned. The disadvantages, however, in employing such solution alone as the galvanizing solution are that the coating is formed very slowly, the thickness is not directly proportional to the amount of the current or the length of time which it has flowed and there is a consumption of potassium cyanide, a comparatively expensive ingredient. The fact that it is an extremely poisonous substance attaches considerable danger to its use, especially where the articles plated are such as may be used for culinary purposes.

In employing the former class of striking materials, the striking solution may be combined with the working solution, while in the latter case the article receives its preliminary coating in the striking solution and is then transferred to the working solution. During the transfer it is very essential that the article be thoroughly rinsed off to prevent any alkali which might otherwise adhere to it, causing a precipitate in the plating bath.

After determining upon a satisfactory solution for zinc deposition, the most important feature upon which successful operation is dependent is in the preparation of the surface to receive the deposit. The cost of labor and materials involved in the operation is the largest item of expense, and comprises about one-half the cost of electrogalvanizing. There is a great lack of uniformity of practice in this work, and it is here that the greatest opportunity for improvement lies.

A common method of procedure is to remove oil or grease by immersing the iron for one-half hour in a hot alkali solution containing about two to eight ounces of caustic soda per gallon of water. Scale and rust are removed by pickling in a 5 per cent. to 10 per cent. solution of sulphuric acid. Heating the solution increases its rapidity of action, but involves a complication of apparatus which is somewhat expensive on account of the difficulty of design, to avoid corrosive action of acid. Hydrochloric acid is frequently used and hydrofluoric acid is employed for removal of sand and scale from castings. As previously stated, the sand blast is a most effective method of cleaning, and its employment is steadily increasing.

Aside from improvement in the preparation of surfaces we may expect electrogalvanizing to become more extensively employed

through better methods of handling the materials, suspension in and removal from the baths, and in simplification of the maintenance of solutions. It is also possible that the rapidity with which zinc may be deposited will be increased, and thus remove the principal disadvantage which is attached to electrogalvanizing, as at present applied. These are problems which are suitable for investigation from the scientific as well as from the technical standpoints, and the solution of which will do much toward promoting the already important electrogalvanizing industry.

Parallel Operation of Direct-Connected Alternators.

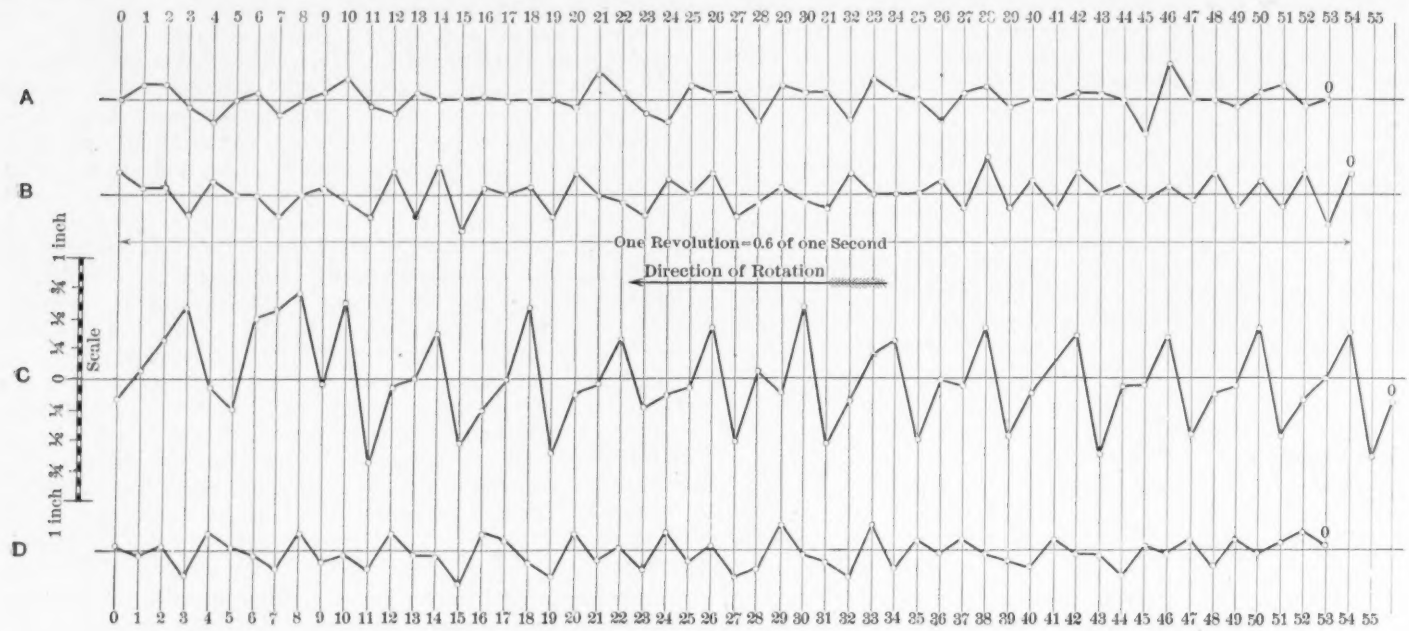
BY P. C. OSCANYAN.

THE numerous articles published relating to the operation in multiple of direct-connected alternators to Corliss engines, have been read by the writer with considerable interest, but generally have impressed him as being somewhat biased. The engine man deals with the subject from his point of view, and the generator man from his. The subject has been pretty well covered, and the requirements of engines for multiple operation have been duly set forth, as have also those of the generators. It seems to the writer, however, that the subject has not yet been dealt with from a point of view which treats of the unit as a whole, which is the correct point of view, inasmuch as the fundamental requirements for multiple operation of the generator are affected by the engine, and those of the engine are influenced by the generator; for instance, the generator requires that the engine to which it is connected shall have uniform rotation, which in a slow-speed Corliss engine, say of 100 r. p. m. or less, is a practical impossibility. On the other hand, the rotation of the engine should be unaffected by the generators when in multiple, which is also an impossibility. Therefore, the solution of parallel operation lies not in the individual design of the engine or generator, but of the unit as a whole.

In operating alternators direct-connected to Corliss engines, we have an equilibrium to maintain, which may be considered analogous to a pendulum standing at rest in the theoretical condition of absolutely uniform rotation; but the engines being operated by pulsations of steam receive sudden impulses which destroy this equilibrium and start the pendulum to swinging. The generators, by virtue of their synchronizing power, instantly tend to draw the pendulum back to its normal position; if the synchronizing power be too great the pendulum will be drawn past the perpendicular, and in due time will receive another steam impulse, which, if it is imparted at a maximum point in the swing, will increase the pendulum action and so on, until the generators go out of step.

To demonstrate that this pendulum action is an actual fact and not a theory, the writer has devised an apparatus to measure and record the variation in angular velocity of fly wheels. This apparatus consists of a device which will mark on a moving object or strip of paper stretched around the periphery of a fly wheel, at regular intervals of time, at the rate of 80 marks per second. When it is desired to make a record a strip of paper is stretched around the wheel to be indicated, and the lap stuck with shellac. The unit is started and put into operation, operating without load, and the marking apparatus put in close proximity to the wheel; and at the desired moment the marks are made upon the strip of paper. The unit is then put in multiple and another record taken for comparison. When a record is made and the marks upon one section of the circumference of the wheel are found to be a greater distance apart than on the others, it shows that the rotation at that part of the revolution was accelerated. If the marks are found to be closer together, retardation from uniform rotation is indicated.

Curves plotted from records taken when units would not operate satisfactorily in multiple are shown in Fig. 1. These curves are plotted upon a horizontal line representing perfectly uniform rotation, being the time of one revolution, which in this case was sixtenths of a second. The vertical lines represent time, being one-eightieth of a second apart, and are the intervals of time at which the recording apparatus marked upon the record, being numbered from 1 to 55. The curves are plotted by measuring the distances between marks on a record, and the sum of their total divided by the number of marks, to obtain the average speed of uniform rotation.



PARALLEL OPERATION OF DIRECT-CONNECTED ALTERNATORS.

The marks on the record above the average, denoting acceleration, are placed above the horizontal line representing uniform rotation, and the marks below the average, denoting retardation, are placed below the line. The vertical scale in this illustration is multiplied four times, in order to facilitate comparisons of curves.

Curve *A* was taken on one of the units running idle. Curve *B* was made immediately after paralleling; curve *C* about five minutes after the unit was put in multiple, and curve *D* with the unit running singly under load. Comparing curve *B*, which was taken immediately after paralleling, with curve *A*, the effect of the synchronizing power of the generators upon the rotation of the engine, is clearly visible, and in curve *C*, taken five minutes later, the influence of the generators has affected the rotation of the engines to such an enormous degree, that the units are almost at the point of going out of step. That portion of curve *C* denoting extended acceleration, from numbers 1 to 10, is particularly interesting as it indicates the result of the pendulum action hereinabove mentioned, it being evident that a steam impulse has been imparted at a maximum point in the swing of the pendulum.

The result of this pendulum action may be observed on the indicating wattmeters of units that will not operate satisfactorily in multiple, and the beats counted. In cases observed by the writer, these beats have ranged from 97 to 216 beats in 300 r. p. m.; and units that would not operate with 168 beats in 300 r. p. m. would do so

perfectly with from 97 to about 125 beats. So it goes to show that success and failure in multiple operation are not far apart. That the frequency of the beat is partly due to the synchronizing power of the generators, may be demonstrated by increasing the self-induction of the armature by cutting down the field current, which results in a decrease in the frequency of the beats. That the frequency of the beat is also partly due to the engine, is demonstrated by the operation of two installations having identical generators, one installation having engines with heavy fly wheels, the other having light fly wheels. The frequency of the beat in the case of the installation with the heavy flywheels is 144 beats in 300 r. p. m.; whereas in the installation having the light flywheels, the frequency of the beat is 216 in 300 r. p. m.

Successful operation may, however, either depend upon the frequency of the beat or its amplitude. The frequency of the beat depends fundamentally upon the synchronizing power of the generators in combination with the moments of inertia of the units. The amplitude of the beats depend upon the dampening effect in the construction of the generator fields, together with the sensitiveness of the engine governors and the number of cylinders. The greater the dampening effect of the generator fields, the more sluggish the governor and the fewer the cylinders result in a beat of the smallest amplitude and the most satisfactory operation. The designer of the generator must take into consideration the design of the engine, and the designer of the engine must take into consideration the design of the generator in the construction of the unit; and the frequency and its amplitude should be predetermined, which is a simple matter of mathematical calculation. If the designer of the generator ignores the construction of the engine, or *vice versa*, satisfactory paralleling will be a matter of chance, which is hardly consistent with intelligent engineering.

Underground Work for Telephone Exchanges—III.

By Arthur V. Abbott, C. E.

2.—CEMENT DUCTS.

ONE of the earlier pieces of conduit construction is the system in New York installed by the Empire City Subway Company. In the commencement of this work the plan of embedding wrought-iron pipe in concrete was adopted, on the theory that while in time the pipe might, and probably would, rust away, a sufficient interval would elapse to permit the concrete to become perfectly hard, so that if the pipe did disappear a continuous concrete block pierced with a corresponding number of holes would remain. Experience has verified this expectation, and in many places at least the iron has vanished, but the concrete holes remain, forming a most excellent duct system. There are two objections to this plan: the iron pipe is exceedingly expensive, costing from 15 to 20 cents per foot (depending on the price of iron), exclusive of the cost of laying or street work. So long as the pipe is intact a serviceable tube is gained, and after oxidization has completely destroyed the metal the concrete tube is equally good, but an interval exists when the pipe is partially destroyed when the ducts may be filled with sharp jagged slivers of partially corroded iron that are likely to destroy the cable sheath in drawing in and out.

To minimize expense and avoid injury to the cable sheath many attempts were made to fashion a tube of some other material, but only two of these have survived the test of time and have gained any considerable vogue in the conduit field.

The first of these to appear was the so-called *"Cement-Lined Pipe."* The manufacture of this duct has been brought to a high state of perfection by the National Conduit and Cable Company. The process consists of first fashioning a tube about 4-in. in diameter by riveting up thin sheet-iron after the fashion of a stove pipe. A mandrel about 1 inch less in diameter than the tube is then inserted therein, the remaining space rammed full of hydraulic cement. After the cement is set the mandrel is withdrawn, leaving a composite pipe, consisting of a sheet-iron exterior and a lining of cement. The iron casing forms a mold to retain the cement in position during the process of hardening, and continues to protect it during the somewhat trying processes of shipping, handling, carting and laying in its concrete bed in the street. As with iron pipe, the idea is advanced that if the sheet casing rusts away after the pipe is laid, no harm can result, as by that time both the cement lining and the concrete matrix of the conduit will have the ample time to completely solidify. Further, it is argued that the casing being completely enclosed in cement and concrete it will not oxidize to destruction. Which of these theories is true matters little—probably both are—for in some cases the casing does entirely disappear, and in others it is preserved; but as far as the serviceability of the conduit is concerned no difference can be detected, and it is immaterial whether the iron rusts or not. Cement-lined pipe is usually made with a bore about 3 inches in diameter, in lengths of about 5 feet. Each piece is supplied with a male and female socket, somewhat similar to the pump log, so that successive lengths may be centered and fitted into the preceding ones. After the trench in the street has been excavated and the bottom graded, a layer of about 3 inches of concrete is carefully spread thereon and leveled. On this, as a bed, the first row of ducts are placed, spaced about 5-in. centers, lightly tamped in place. Then a concrete of fine stone or a very coarse mortar is spread over the ducts, filling completely all insterstices between them. A sufficient clearance is placed on top of the pipes so that the next row may be spaced about 5-in. vertically. As each piece is laid it is driven home on the preceding one, and mortar packed tightly about the joints. When a sufficient number of pipe have been laid to gain the desired cross-sectional number of ducts, 3 inches of concrete are packed about the sides and on top, and the street refilled and paved.

FIG. 6.—CEMENT-LINED PIPE SUBWAY.

Fig. 6 gives a detailed view of cement-lined pipe construction, while Fig. 7 shows the general method, illustrating the flexibility of this form of duct in turning a curve. Cement-lined pipe meets a large number of specifications for ideal duct material, and so has deservedly won over many friends, hundreds of thousands of feet being in successful operation. It forms, with its concrete encasement, a strong and indestructible conduit, is easily and rapidly laid without skilled labor, and while by no means either moisture or gas-proof, it is as much so as most market forms. The duct surface is reasonably smooth and cables pull easily. It has as good insulation as any form of silicious duct material. Its chief handicap has been the price charged per duct foot by its manufacturers, which—notwithstanding the fact that the installation cost of cement-lined pipe is less than that of several other forms—has made the total expense per duct foot of conduit built of this material greater than that of some other kinds.

Within the past few years several attempts have been made to

cheapen cost of manufacture by avoiding the use of the objectionable sheet-iron casing. These processes have taken the form of manufacturing a concrete tube from a mixture of Portland or other superior brand of hydraulic cement and very sharp crushed rock, pressing the same into a tubular form, either in a mold or through a die. The Francis duct and that manufactured by the Western Stone Conduit Construction Company are the best examples of these attempts. The pieces are made in lengths of five to six feet, but no socket joints are provided. Duct material is laid in conrete, exactly in the same manner as cement-lined pipe, excepting that the joints are simply butted, a tightly fitted rubber mandrel being placed at each joint, while the concrete is tamped around it, thus easily insuring good alignment. The advocates of this form of duct material claim that, owing to the absence of the metal casing, a much more perfect union between the encasing concrete is gained, and thus a stronger and more homeogenous structure; that the absence of the socket joint does not in any way militate against its value as a duct material; as the pipe can be readily cut with an ordinary bucksaw; breaking is minimized, and no special short lengths are needed to complete sections. Theoretically, all these claims are probably true, but practically they are imperceptible in the actual working of the conduit in contrast with that built of other forms of duct material. Cement-pipe of this description is quite rough on the inside and cables pull hard, nor does the absence of the iron casing cause its manufacurers to quote prices that have as yet gained for it a widespread introduction. An example of the practice of the Western Stone Conduit Construction Company's work will be found in Fig. 8.

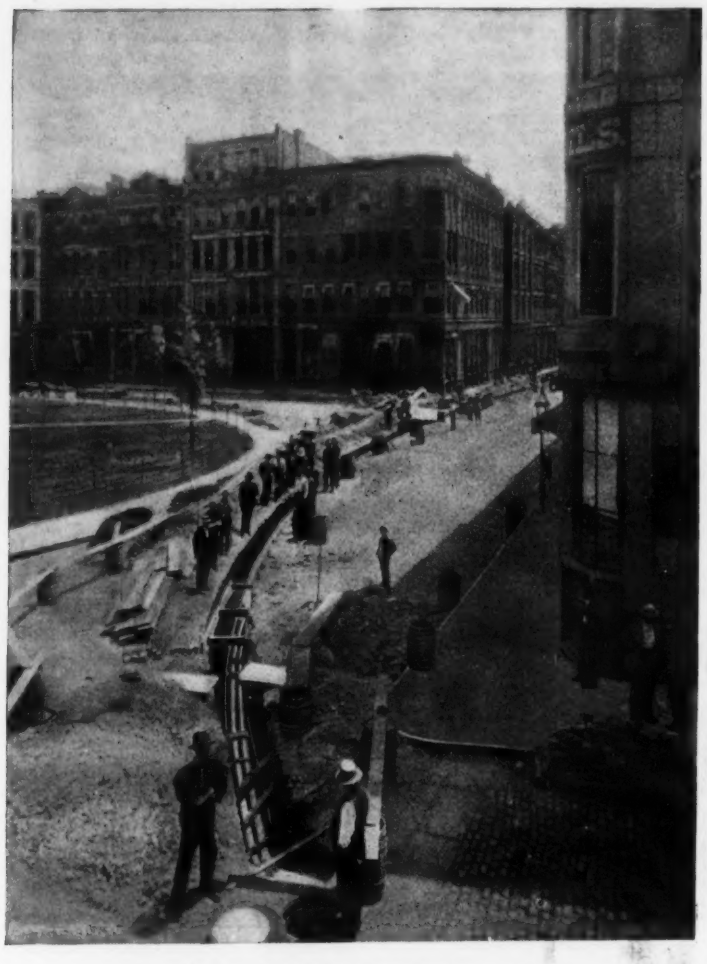


FIG. 7.—CEMENT-LINED PIPE CURVE.

FIG. 8.—LAYING CONDUITS.

3.—VITRIFIED CLAY DUCTS.

History is silent as to the inventor of the vitried clay duct—that very popular, and, on the whole, most valuable of duct material. Probably some ingenious but unassuming engineer pulled his cables through an old drain pipe, and lo! the tile manufacturers commenced flooding the country with vitrified pipe ducts of all descriptions. Some time in the early 80s the H. B. Camp Company placed on the market a particularly formed clay pipe. It was about 4 feet long and 10 inches square, hence in the vernacular it became known as *"ten by ten."* A partition running through the center of this clay box causes each piece to supply two rectangular holes about 4 ins. x 9 ins. inside. This form is shown at *A*, Fig. 9. The early conduits constructed of this material were made by carefully leveling the bottom of the proper street excavation and placing successive lengths of tile thereon. The joints between the several pieces were made by wrapping several layers of jute or burlap, previously dipped in hot asphalt, around the ends to be joined, and then painting the last wrap with a liberal coat of the melted hydrocarbon. This form of conduit was intended to carry three cables in each division of each piece, and there are many thousand feet that after more than a decade of severe service are doing good work, and seem likely to remain serviceable for a generation to come.

Experience developed two faults: It was found difficult to withdraw cables without injury when as many as three were allowed to remain exposed to the impacting influence of the dust and dirt that creeps into the best subway, and duct material laid with no foundation was prone to settle and fall a prey to the predatory pick. With a 10 in. x 10 in., the latter difficulty was easily cured by placing the duct material on a good 3-in. foundation of concrete, supplying the sides and top with a similar protection, supplemented with a strong piece of 1½-in. plank, but the difficulty of withdrawing the cables was not so easily cured. To meet this objection the Camp Company produced the *"hollow brick."* This form is illustrated in Fig. 10. It consists of the vitrified clay pipe, essentially circular in external section, with the corners chamfered, having a round hole about 3¼ ins. in diameter extending through it. Each piece is about 18 ins. long, 4¾ ins. in outside diameter. A subway of any desired magnitude is easily built by laying up, brick-wall fashion, on the proper concrete foundation, the desired number of hollow bricks to gain the required number of ducts. As each piece is laid it is covered with cement mortar and carefully tamped with a trowel to a proper bed, in exactly the same fashion as brick masonry. As the ends of successive pieces form but joints, a wooden mandrel, closely fitting the pipe hole and long enough to cover at least three joints, is placed in each line of duct and pulled along as fast as successive pieces are placed. This mandrel is shown in Fig. 11, and the method of using it in Fig. 12. At one end a ring enables the mason, who is supplied with a long hook to grasp, and pull the mandrel along, while at the

rear a leather or rubber disk that tightly fits the bore of the pipe scrapes away in its passage any superfluous mortar that may have entered through the joints.

In Fig. 13 a partially completed line of hollow brick conduit is shown. The trench is carefully leveled and supplied with the necessary three inches of concrete foundation. Then the hollow brick is

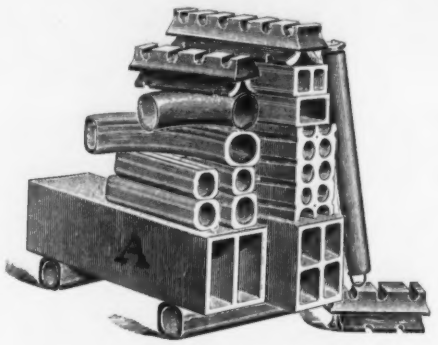


FIG. 9.—"TEN BY TEN."

piled up, the alignment being secured by a chalk line stretched through the center. As fast as successive pieces of tile are placed, the mandrels are pulled along, the rings of which will be noticed protruding from the ends of the ducts.

In Fig. 14 a finished conduit is shown, with the full concrete encasement ready for the refillment and repavement of the street. The

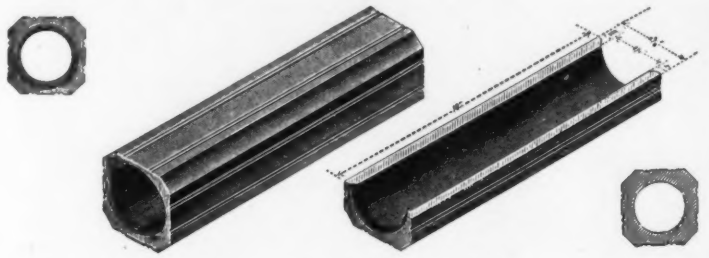


FIG. 10.—HOLLOW-BRICK DUCTS.

Camp hollow brick was a very distinct and very long stride in the art of duct material making, for it provided something that was indestructible, so far as the decomposing action of street soils were concerned, secured all of the advantages of the single duct space, was sufficiently flexible to lend itself to subways of any desired magnitude, possessed sufficient flexibility so that curves could be turned with ease, and intrinsically was a thoroughly good insulator; while the interior was smoother and easier on the cable than any

FIG. 11.—MANDREL FOR HOLLOW BRICK.

other form except the soft and greasy surfaces of creosoted wood. The hollow brick, however, labors under the disadvantage that it is impossible, without going to the most extraordinary labor and expense to build a conduit that is even remotely moisture and gas-proof, and as it needs the use of a trowel in laying, trade unions have declared that only skilled masons shall be employed, thus saddling those who use this duct material with either the payment of

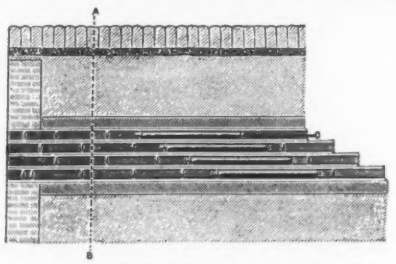


FIG. 12.—SHOWING USE OF MANDREL.

union rates of wages, or the prospect of a strike and a fight against the arbitrary tyranny that American trade unions always endeavor to inflict. Being laid in 18-in. lengths great flexibility is secured, handling is easy and rapid, and it is claimed breakage is reduced to a minimum. Contrawise, where conduits of a considerable number of ducts are to be installed, the labor in handling so many small pieces becomes excessive. With these manifest advantages, it is not surprising that hollow brick promptly captured and has held the bulk of subway construction for a number of years, and that many millions of duct feet have been placed and are now in operation.

The desirability of some form of duct material which could simultaneously preserve all the advantages of the hollow brick, minimize handling and obviate the necessity of skilled labor was early recognized, and the clay men atavistically returning to the old "10 x 10" idea tried to make clay shapes of long lengths containing several cable spaces, hence the so-called "Multiple Duct," of which the McRoy Clay Works were the pioneer exponents. The general type of the McRoy duct and simplest method of laying is shown in Fig.

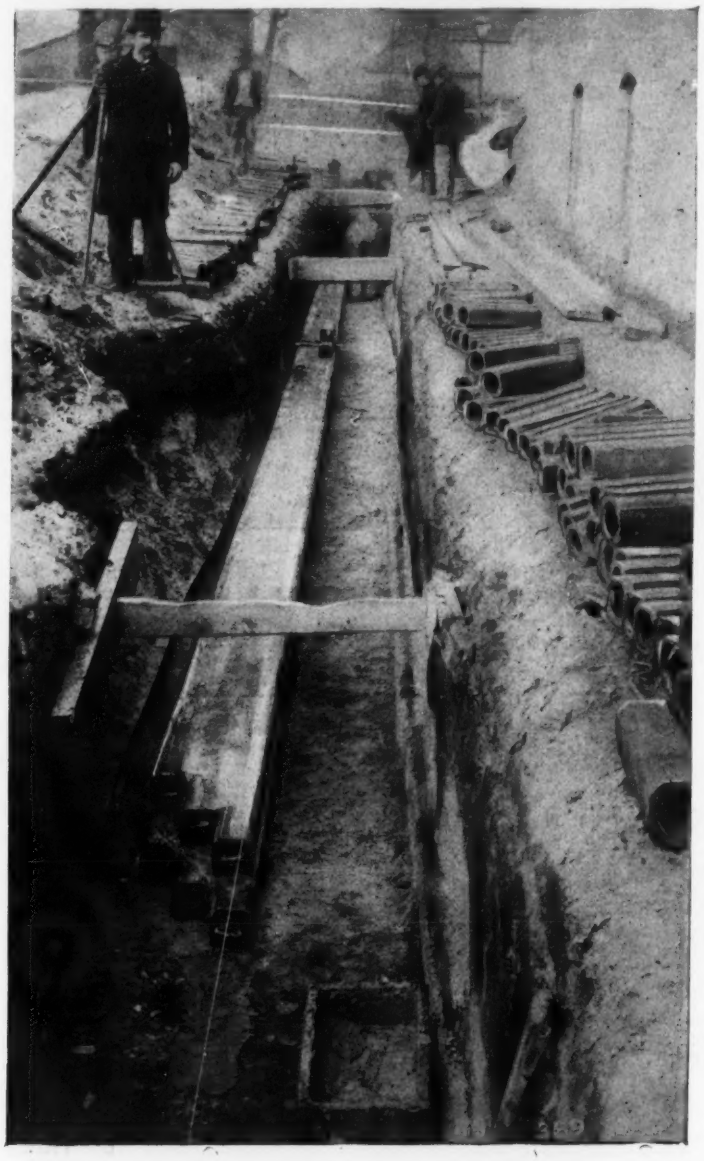


FIG. 13.—PARTIALLY COMPLETE HOLLOW-BRICK CONDUIT, SHOWING MANDRELS.

15. The clay sections are made in lengths of about 5 feet, and contain 2, 4, 6, 8 or more ducts, as the purchaser may desire. Each length is provided with one or more one-half inch holes molded in the clay partitions, into which iron pins forming dowels may be fastened, thus causing ducts in succeeding lengths to align with great accuracy. Joints are best made as indicated in Fig. 16, by wrapping tightly about each succeeding piece several layers of asphalted burlap. The simplest and cheapest method of laying is that shown in Fig. 15. The proper trench is excavated, leveled, and the requisite number of multiple sections piled up. To secure bearing, a thin layer of mortar is spread between each tier and the trench refilled. standard method is adequate where there is little to be feared from street excavation, but is insufficient in most street work, and the conduit is almost sure subsequently to suffer from settlement. The standard method of building is shown in Fig. 17. After the proper

FIG. 14.—COMPLETED CONDUIT TRENCH READY TO REFILL.

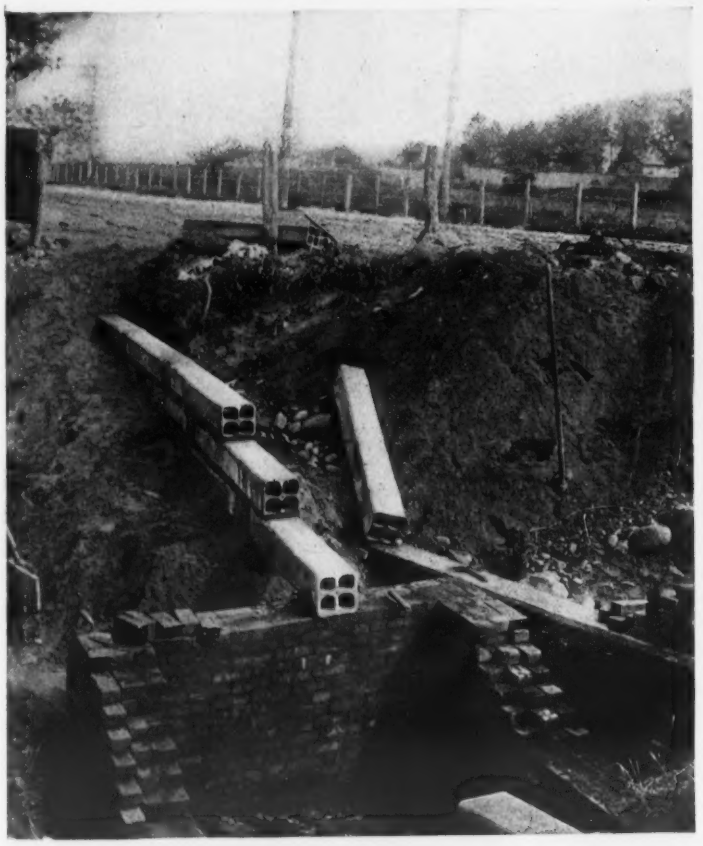


FIG. 15.—MULTIPLE DUCT.

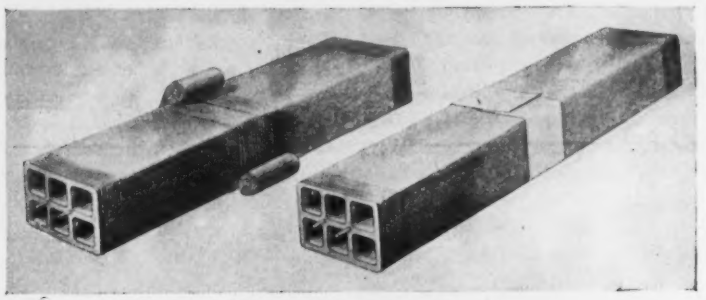


FIG. 16.—MAKING JOINTS ON MULTIPLE DUCT CONDUIT.

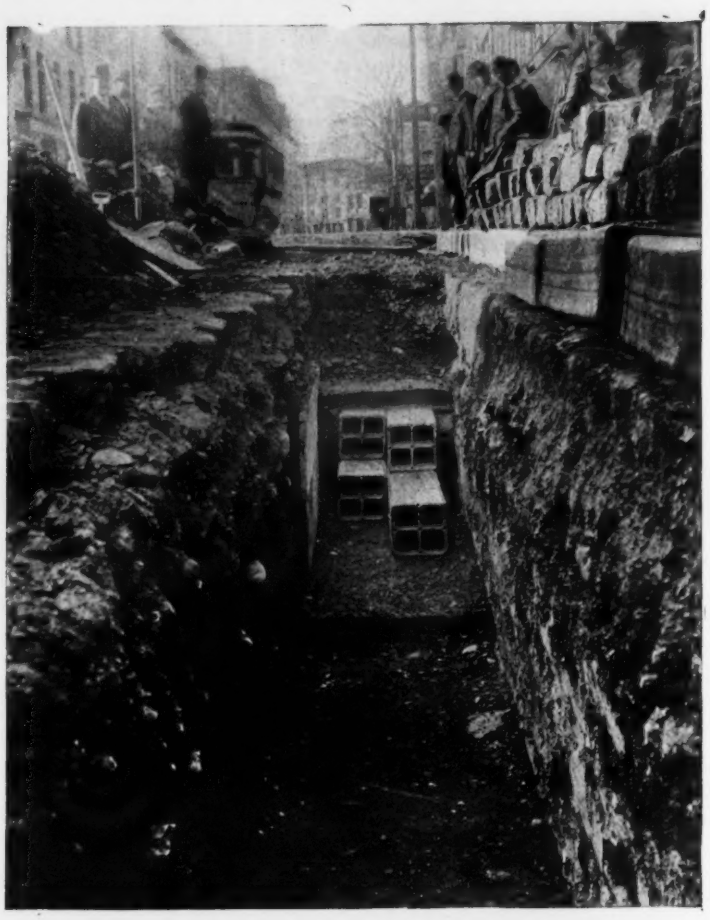


FIG. 17.—MULTIPLE DUCT CONDUIT.

FIG. 18.—MULTIPLE DUCT CONDUIT WITH TIMBER FOUNDATION.

trench is excavated a three-inch concrete foundation is laid, and the sides lined with the cheapest lumber, so spaced as to make a trough 6 inches wider than is needed to receive the proper number of multiple sections. These are then joined and placed on a concrete bed, leaving three inches on each side between the planking. Just as each piece is placed a coating of thin mortar is applied to the clay surfaces in contact with each other. When all the duct material is in place the side spaces are tamped full of concrete and a three-inch

FIG. 19.—CEMENT PIPE AND DUCTS.

cover of the same material completes the work. In some instances the cheaper plan of using a lumber foundation has been adopted, as shown in Fig. 18, which is mentioned only to be avoided. Lumber in such a situation will sooner or later surely rot and allow the conduit to settle, thus ruining what would otherwise be a first-class piece of work.

In Fig. 19 an example is given of the McRoy ducts and cement-lined pipe comfortably and amicably occupying the same trench, utterly oblivious of the probable rivalry of their respective manu-

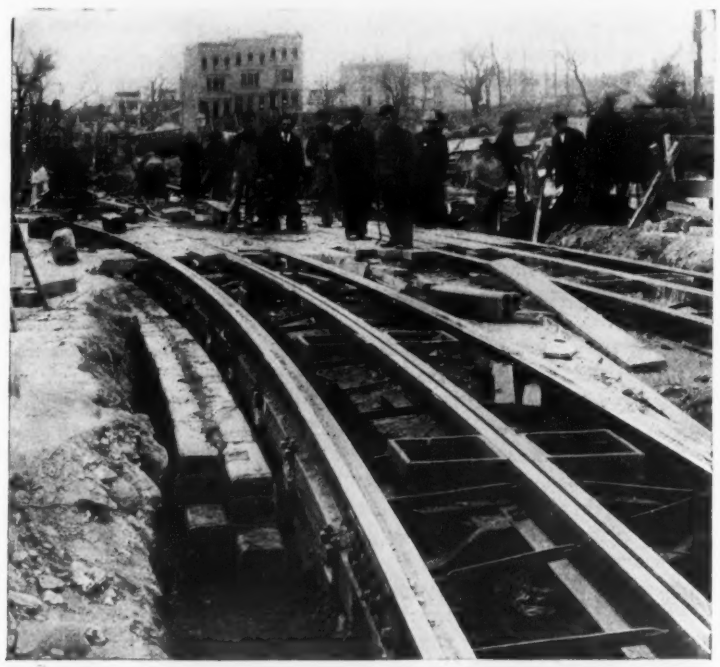


FIG. 20.—MULTIPLE DUCT CURVE.

facturers, while in Fig. 20 the practical, perfect flexibility of the multiple duct is shown in the ease with which a curve may be constructed.

The manufacture of multiple duct conduit struggled for a long time with indifferent success, as with every additional duct the difficulty both of molding the sections and of burning them without excessive wastage due to unequal shrinkage become very great, but with sufficient application of American perseverance these troubles were gradually surmounted, and following the lead of the McRoy Company many other tile manufacturers entered the conduit field until at present there are a number of firms, among which the engineer has ample opportunity for a wide selection.

Each of the various manufacturers produces a product which differs usually in unimportant details, from that of all others. Each maker claims some particular merit for little wrinkles which distinguish his output from that of others. A single example will, however, suffice to illustrate the forms of duct material from which the engineer is now able to select, and the line of duct material offered by the American Vitrified Conduit Company is large, diversified, excellent and thoroughly representative of the best present practice in the manufacture of duct material. The various single duct forms now put upon the market by this company are illustrated by Fig. 20. A slight analysis will reduce these to four types: The square form, in which each piece is a true rectangular parallelopipidon having full corners so that it may be laid up in a solid wall exactly after the fashion of brick work. At the other extreme is the cylindrical duct or pipe which precisely resembles an ordinary drain pipe minus the bell. Intermediate between these two is a hexagonal duct and a form with fluted or semi-circular corners. These respective types are marked *A, B, C* and *D* in Fig. 20.

Electrical Mining Plant for Nevada.

The famous Bamberger-De La Mar mines at De La Mar, Nevada, are installing at their properties the largest electrical plant of its kind in the west for mining purposes. The principal feature of this plant is the fact that De La Mar is located about 30 miles from the railroad, fuel is comparatively an expensive element in the handling of the ore, and the use of coal is prohibitive on account of the long, expensive haul. Heretofore, the company has been compelled to burn wood at a very large expense. This new plant will be about six miles from Calientes, on the new Short Line extension.

The purpose is to generate the power there and transmit it about 14 miles, at 30,000 volts, to De La Mar. The generator station will consist of two 600-hp generators, each having a maximum capacity of about 1,000 hp, driven by engines furnished by the Allis-Chalmers Company. This will supply power to the two mills at the Bamberger properties. One mill will work the ores as they come from the mines and the other mill will be used for working the tailings which have accumulated there for the past ten years, and which contain very high values.

Induction motors will be used, varying from 50 to 100 hp, distributed throughout the mills. In addition to this a 150-hp motor will be used in driving a compressor to supply power for drills. The April Fool and Magnolia properties which have been absorbed by the Bamberger interest will also use power from the same line for operating their mill and compressor. One 75-hp electric hoist will be installed at the De La Mar mines, and this will be driven by a 75-hp General Electric induction motor of the variable speed type, which has proven entirely successful for hoist work. The town of De La Mar will also be lighted with alternating current from the same line. The lighting conditions will be considerably improved there on this account.

The water supply for De La Mar and the mills is furnished by a pumping system from the Meadow Valley Wash, where the generator station will be located, supplied by a pipe line about 14 miles in length, with a total lift of over 1,000 feet. On account of the high pressure it is necessary to have three stations along the line where steam-driven pumps are at present used. These pumps will be driven by induction motors, which will receive their current from the transmission line. This will save considerable money on account of the high price of fuel, in addition to the pumps operating at high efficiency.

The work of installing this extensive and well-designed plant is in charge of Mr. F. G. Janney, engineer of the Bamberger Company, and M. D. Grosh, district engineer of the General Electric Company. Much credit is due the Bamberger Company for their good judgment in this pioneer movement, which is bound to result in great economy in the reduction of operating expenses, and will also bring them increased profits from these magnificent properties.

CURRENT NEWS AND NOTES.

WIRELESS TELEPHONY.—Experiments in wireless telephony were, according to a Berlin dispatch, successfully conducted on August 24, over a distance of 105 miles, between Sassnitz and Kolberg.

ITALIAN NAVY TO AID MARCONI.—A despatch from Rome states that King Victor Emmanuel has ordered that the battleship "Carlo Alberto" be placed at the disposal of Signor Marconi for experiments in wireless telegraphy between Europe and America. This compliment is significant in view of the warfare waged against Marconi in England, largely on the score of his nationality.

A PRIZE FOR RADIUM.—In *The Cosmopolitan* for September a brief article is published under the title, "A New Field for Speculation," and announcement is made of a prize of $300 for the best paper on the subject of radium and the best way of securing a cheaper and larger supply of it.

DEGREES FROM NORWAY.—In connection with the centenary of the birth of Niels Henrik Abel, the Norwegian mathematician, which was celebrated September 4, at Christiania, Norway, honorary degrees of Doctor of Mathematics have been conferred on 29 foreign scientists, including Prof. Simon Newcomb, Prof. J. Willard Gibbs and Lords Kelvin and Rayliegh.

ELECTRICAL MANUFACTURE OF GLASS.—A patent issued September 2 to Jegor Bronn, of Cologne, Germany, describes a process for the electrical manufacture of glass, which is designed to avoid the difficulty experienced when working with powdered material. The raw material is supplied with a binding agent, kneaded and then caused to pass between heated rollers into the melting furnace in the form of a ribbon or sheet, which is there subjected to the action of an electric arc.

OCEAN WIRELESS TELEGRAPH STATION.—According to a London despatch, it is proposed to install a combined lightship and ocean wireless-telegraph station 100 miles west of the Lizard. It is suggested that a vessel provided with a powerful searchlight, whose beam shall be projected against the clouds, mark the position of the station at night. The wireless telegraph plant is to be powerful enough to command the fairway of the Channel and exchange news and orders with passing vessels.

DOCTORATES OF PHILOSOPHY.—In some statistics relating to Doctorates of Philosophy and their distribution, *Science* gives the total number of degrees conferred in this country during the past few years as 1,158, of which 568 were conferred in the sciences. The institutions considered do not include those that "have no right to confer the degree, giving it for work done *in absentia* or, perhaps, for the payment of a fee." Our contemporary recognizes 27 universities as qualified to confer the degree of Ph. D.

GERMAN SUBMARINE CABLES.—Although Germany has lately shown activity in developing her system of ocean cables, only 4 per cent. of the world's total mileage is hers. Consul J. F. Winter reports that, according to statistics just issued, the German cable system consists of 73 lines, connecting different parts of the home territory, six with the colonies, and 19 with foreign countries, making a total of some 17,000 miles. One-third of all the German cables are state concerns.

FIRE INSURANCE TOPICS are to be discussed at the convention of the International Association of Fire Engineers, to be held in New York City on September 16, 17 and 18, including "How to Prevent Electrolysis," by Capt. William Brophy, of Boston; "The Fire Department of the Future in Large Cities," Chief George W. Horner, of Baltimore, and "Progress in Fire-Alarm Telegraphy," by J. W. Stover, president of the Gamewell Fire-Alarm Telegraph Company. The convention will be held at Grand Central Palace, where there will be also a complete exhibition of fire-fighting and life-saving apparatus. Some 75 exhibitors have already arranged for space.

A. I. E. E. MEETINGS.—The regular monthly meetings of the American Institute of Electricial Engineers will be recommenced at 12 West Thirty-first Street, New York, on Friday, September 26, 1902, when a paper will be presented by B. G. Lamme, of Pittsburg, on "The Washington, Baltimore and Annapolis Single-Phase Railway." This paper will be the first publication of the new Westinghouse single-phase railway system. At the following meeting, which will be held at the same place, on Friday, October 24, 1902, a paper will be presented by Prof. Charles P. Matthews, of Lafayette, Ind., on "An Integrating Photometer for Glow Lamps and Sources of Like Intensity."

TELEPHONIC DISTURBANCES FROM ELECTRIC RAILWAY.—A patent issued September 2 to Hermann Brockelt, of Berlin, Germany, describes an arrangement designed to obviate disturbances to telephone circuits from railway return currents. These disturbances are stated to be due to the fact that the counter e. m. f. in street railway motors is not absolutely constant, and can be resolved into a uniform e. m. f. and a relatively smaller alternating e. m. f. To counteract the effect of the latter, the current going to the rails passes through the primary of a transformer, the secondary of which is connected across the motor and its field. It is stated that the alternating e. m. f. in the secondary will exactly counterbalance the alternating e. m. f. of the motor so that the current going to ground will have no pulsations.

LETTER TO THE EDITORS.

The Second Law of Thermodynamics.

To the Editors of Electrical World and Engineer:

Sirs.—In your recent discussion of the second thermodynamic law the interesting question is raised whether it embodies a limitation in nature, or merely in man. The fact that the law has been employed by Clausins, Helmholtz, Van't Hoff and others for many broad generalizations in physics and chemistry which have been amply verified by experience would lead us to believe that the first named is the correct view, since it would be strange indeed if so many correct conclusions could be deduced from a false premise.

Your correspondent calls attention to the alleged limitation of the law embodied in Maxwell's conception of demons, who, by their discrimination between the velocities of molecules, could cause heat to flow from a cold to a warm body; but it should be noted that the power to perpetually reproduce a difference of temperature in a system of uniform temperature, depends upon that assumption of the kinetic theory which requires perfect elasticity of the molecules of a gas, and it is, therefore, of interest to inquire whether that assumption is essential to the theory.

The following considerations will illustrate one of several alternative hypotheses which seem to leave the kinetic theory very nearly where it is, without necessitating the abandonment of the second law as a true law of nature.

In speculations upon the mechanical conditions obtaining in a gas, attention has often been directed to the analogy presented by the stars and stellar systems of the visible universe, and I believe that in this case some light may be obtained by the consideration of such an analogy. If we replace the conception of impact of molecules by that of the deflection resulting from the combined influence of gravitation and inertia, such as is illustrated by the revolution of comets about the sun, we have introduced no new and unknown property of matter, such as "absolute" elasticity, and yet would seem to have accounted for the properties of gases as well as by the assumption of impact. The idea thus suggested admits of much further elaboration, which I shall not attempt here, and, indeed, ultimately reduces the three fundamental properties of matter to two by interpreting impenetrability as but a consequence of the possession by matter of gravitation and inertia; but one of the consequences of such a view is that the second law of thermodynamics remains intact.

Perhaps the simplest expression of the second law is embodied in the statement that "No isolated system is reversible," and in spite of the appearance of perpetual motion and complete reversibility in such an aggregate as the solar system, yet many considerations which need no mention here convince us that it is slowly running down, and that in time, its energy, both kinetic and potential, like that of all systems, will be dissipated into heat. Man corresponds to Maxwell's

dæmon in this magnified gaseous system, and does, in fact, utilize the energy of motion of the magnified molecules in tide mills; and we have merely to transfer the comparison to imaginary beings, operating with the molecules of gases to see that they would have no better reason than man to anticipate the complete reversal of an isolated system. In other words, if the law we are considering is true, and the kinetic conception of the constitution of matter is correct, then, whether or not we adopt the above view of molecular collision, heat must itself be dissipating into some other form or forms of energy as slowly, perhaps, as the mechanical energy of the heavenly bodies is dissipating into heat. Such a slow dissipation might be no more observable in the one case than in the other. Whatever position we may take on the matter however, even should strict mathematical investigation demonstrate that the above suggested view of the nature of impact is indefensible, the fact remains that the idea of absolute elasticity is incompatible with the second law of energy, and as one must be abandoned it seems to me that it should be the former.

Incidentally I would mention that your correspondent has cited no real violations of the second law (in practice). That law does not assert that heat may not be transformed into other forms of energy in a medium of uniform temperature. It does assert that it cannot be so transformed *reversibly*.

BOSTON, MASS. J. M. MACKAYE.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Direct-current Armatures.—DAVIES.—An article on the choice of the suitable core disc for the armature of a direct-current machine. He compares the relative advantages of the drum armature and ring armature, and seems to favor the former for pressures below 500 volts. For pressures over 500 volts he prefers the ring armature, owing to the greater facilities it offers for the insulation of the coils. The toothed core is said to have the following advantages over the plain core, especially in multipolar machines; the length of the air-gap may be considerably reduced; it offers better mechanical construction, the mechanical drag coming mainly on the iron core itself; there is almost an entire absence of eddy currents in the conductors, owing to their being in a very weak magnetic field. The iron-clad type of core possesses the same advantages, but should never be used for direct-current machines, on account of the high self and mutual-induction of coils wound on such a core, which prevent good commutation. He then discusses the dimensions of the core and gives some approximate formulas, in which the virtual external diameter means the actual outside diameter of the core in a plain apparatus and the diameter measured at the bottom of the teeth in a toothed armature, the virtual internal diameter means in unventilated drum cores, the inside diameter of the effective iron as measured over the ventilating aperture; the net length is the actual length of iron in the core; k is a constant. The formulas are as follows: The output in watts for a dynamo, or in horse-power for a motor, should be equal to k times the net length, times the square of the difference of the virtual external and internal diameters of the core, times the number of revolutions per minute, times the number of poles. For k, the following numerical values are given, the first figure always referring to a drum armature, the second to a ring armature: for a dynamo, 0.020 and 0.052; for an open-type motor, 0.000027 and 0.000070; for a protected type motor 0.000021 and 0.000056; for an enclosed type motor, 0.000018 and 0.000047. In toothed armatures the slots should be in radial depth about 0.125 times the difference of the virtual external and internal diameters of the core. He gives a curve, showing the suitable number of armature sections for various values of the virtual diameter of the armature. He recommends a width of slot which is about equal to the width of the tooth at the outer circumference of the core. The width of the slot at the circumference of the core should never exceed 1.5 times the length of one of the air-gaps. He recommends having the corners of the slots filled in with a small radius at the bottom, as this increases the section of the iron in the teeth where it is most needed, and reduces the hysteresis and eddy currents, besides imparting mechanical strength. The induction in the armature core should not be less than 60,000, nor much more than 80,000 lines per square inch. The mean average induction in the teeth will be somewhere between 100,000 and 130,000 lines per square inch, the heavier inductions being used most in generators for electric traction. For multipolar machines the induction in the armature core and teeth should be sligthly lower than in bipolar machines. While provision should be made for bolting up the discs fairly tight, in order to ensure a sound mechanical job, yet it is not advisable to subject the discs to any more pressure than is really essential, as the pressure increases the hysteresis loss. Preferably the bolts should not pass through holes in the discs at all, but through the center of the discs.—Lond. *Elec. Rev.*, August 22.

LIGHTS AND LIGHTING.

Enclosed Arc Lamp.—An illustrated description of an enclosed arc lamp made by a British company for single operation on 200 to 250 volt, direct-current circuits. It is said to be quite as efficient as the long arc-multiple lamp, and to give a perfectly white light, equal in quality to that from a standard 5-ampere, 80-volt arc. To obtain these advantages, it is necessary to divide the voltage equally between two arcs, and this is done in the "twin-carbon" lamp. The standard lamp takes 2¼ amperes, and the four arcs are in series, with 80 volts at each arc. The controlling mechanism is very simple, consisting of a steadying resistance and a pair of magnets connected in series with the two arcs across the 200 to 250-volt line. A single armature operates the clutches for both carbons, so that both feed together, and it is impossible for one arc to rob the other to an appreciable extent. The carbons are placed very close together, so that to the observer the effect is the same as if the light emanated from a single arc. Eleven mm. carbons are used, and with 12-inch upper and 5-inch lower the lamp will burn 130 to 150 hours with one trimming.—Lond. *Elec.*, August 22.

POWER.

Electric Power in Mines.—JACKSON AND COCHRAN.—An article on systems of electric power for soft coal mines. A system, using direct current for both haulage and other power; has the advantage of great simplicity, and is the most economical system for small lines. A second system is the use of direct current for haulage and polyphase alternating currents for other power and lighting. An example of this class is a large plant at Elkins, Va., where 500-volt direct current is used for haulage, while the power house also contains three-phase generators, the three-phase currents being transmitted at 2,000 volts into the mines, where the voltage is reduced by transformers at 250 for lighting and for supplying the induction motors which drive the coal cutters and pumps. A third system is to have a polyphase generating station transmission at 1,000 to 10,000 volts in the mines, with converter substations in the mines; direct current at 250 volts is then used for haulage; the other apparatus and the lighting can either be supplied in the form of direct current or of alternating currents, preferably the latter on account of the advantages of the induction motors. In order to avoid the converters, the power stations may contain double-current generators, generating both direct and alternating currents at the same time. This is done at the large plant at Ehrenfeld, Pa., which is described in some detail.—*Eng. and Min. Jour.*, August 16.

British Central-Power Station.—An illustrated description of the electric supply station at Neptune Bank, Newcastle-upon-Tyne, which is the first company supplying electric power in bulk in England. Three-phase currents, at 5,500 volts, and with a frequency of 40 cycles per second, are transmitted to the various substations, in which by means of transformers and synchronous motor-generators conversion is made to 480 direct current for power and lighting on the three-wire system, and to 440 volts alternating, three-phase currents for power alone. The alternators are driven by four 1,400-hp steam

engines. There is also one 1,500-kw turbo-alternator, running at 1,200 r. p. m. As a prime mover of electrical machinery, the steam turbine approaches the ideal; it runs steadily, is free from vibration, and needs little attention; the question of steam consumption has been the difficutly. In the present case it is 18 lbs. of steam per kw-hour.—Lond. *Elec.*, August 22.

Electric Equipment of Railway Yard.—An illustrated description of the equipment of the Chicago Railroad clearing yards. There are two 150-kw, 2,300-volt, three-phase generators in the power house, for furnishing current to various machinery, interior lighting, outdoor arc lighting, etc. In the yard there are 450 switches, and of these the 120 switches along the "ladders of the classification tracks" are operated by pneumatic cylinders which are controlled electrically from the switch tower. The cylinders work under 60 pounds air pressure. The controlling apparatus in the tower comprises a set of 10 push-botton machines, each machine controlling the movement of 12 switches. A battery of 14 accumulators is used for operating the switching system. Two motor-generators are used to charge the battery.—*West. Elec.*, August 30.

REFERENCE.

Canadian Power Transmission.—ADAMS.—An illustrated description of the power transmission to Hamilton, which is said to be the largest electrical transmission plant in Canada. The capacity is 6,000 kw.—*Elec. Rev.*, August 30.

TRACTION.

Electric Traction on Railways.—An editorial stating that an important step toward the "electrification" of the English main railway systems has been made in the determination of the North Eastern Railway Company to introduce electric traction on their Tyneside lines. There will be electrically equipped some 40 miles of double-track line, typical of the suburban railway. While it appears that the third-rail, direct-current system is favored, it is left to manufacturers to tender an alternative system if they can show that it would be beneficient. The specification to which contractors are invited to tender, is reprinted.—Lond. *Elec.*, August 22.

REFERENCES.

Yarmouth.—An illustrated description of the municipal tramways of Yarmouth. The system comprises six miles of single track. The trolley system is used. The generators give 360 amperes each, at 560 volts. The battery consists of 240 cells, of 360-amp.-hours capacity, and works in combination with a "reversible booster" of the Crompton type.—Lond. *Elec. Rev.*, August 8.

Interurban Railways.—GIBSON.—A well-illustrated article on high-speed electric interurban railways.—*The Eng. Mag.*, Sept.

Berlin.—MASON.—An illustrated article on the new electric underground and elevated lines in Berlin.—*Cassier's Mag.*, Sept.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Korea.—MCLELLAN.—An illustrated description of the electric light and traction plant in Seoul, the capital of Korea. The power house contains two 120-kw, double-current generators, supplying 550-volt direct current for traction, and 385-volt two-phase alternating current. The latter is raised in tension to 2,000 volts and transmitted to the different transformers in the city, where it is reduced to 100 volts.—*Cassier's Mag.*, Sept.

REFERENCES.

Storage Batteries in Mills and Factories.—STEBBINS.—A long and well-illustrated paper, read before the Civil Engineer Club, of Cleveland. He says that in time the storage battery will be considered as essential a part of any electrical equipment as any other reservoir (of gas or water, etc.) in plants where the load is intermittent. He describes at length the construction of a storage battery and their installation and use in mills. He briefly mentions that a battery may be of great assistance to a factory when used in conjunction with a gas engine.—*Jour. Ass. Eng. Soc.*, July.

Boston.—Nearly the whole issue is filled with illustrated descriptions of engineering features of Boston. There are articles on the new power stations of the Boston Elevated Railway, the lighting plants of Boston, the Massachusetts Institute of Technology, engineering at Harvard University, power plants of Keith's Theater, and the Tom River Ship and Engine Company, of Quincy.—*The Eng.*, Sept. 1.

Portable Electric Generating Plant.—A brief and well-illustrated description of an electric light plant which can be readily transported from place to place in naval or military service. It consists of an engine coupled to a 105-volt, 600-ampere, six-pole dynamo, mounted on a transporting carriage.—Lond. *Eng'ing*, August 8.

Earthing of Middle Wire.—ABRAHAM.—An article on the reasons for, and the methods of earthing the middle conductor, and a description of a device which records all earths, both small and large, continuously with only one ammeter.—Lond. *Elec. Rev.*, August 22.

ELECTRO-PHYSICS AND MAGNETISM.

Electric Resistance of Steel and Pure Iron.—BENEDICKS.—An account of an extensive series of resistance measurements on eight specimens of Gysinge steel, with different percentages of carbon and other impurities, which gave the following results: First, equivalent portions of various substances dissolved in iron will augment its resistance by equal amounts, as experiments show for the case of *C, Si* and *Mn*, and as may be derived from Wedding's result for the case of *P*, one dissolved atom per 100 atoms of solution raising it by 5.9 microhms per cu. cm., in accord with Le Chatelier's measurements. Second, a definite carbide is not found to have any noticeable influence on the resistance of iron. He suggests, however, that other sorts of steel may exhibit a behavior somewhat different. Third, non-tempered steel with 0.45 to 1.7 per cent. C. holds 0.27 per cent C. in the dissolved state; such steels are, therefore, made up not of carbide and pure iron, as hitherto supposed, but of a carbide and a 0.27 per cent. solution of carbon in iron, this solution probably being identical with Ostwald's "sorbite." A formula for the resistance of steel is also given.—*Ofvers. Kon. Vet. Ak. Stockholm*, Feb. 12; abstracted in *Science Abstracts*, July.

Influence of Electrode Metal Upon Discharge.—STARK.—An article in which he points out that under certain conditions the material of the electrode may have a distinct influence upon the discharge potential of a spark-gap. If the electrode at which discharge first sets in, is an anode, the positive ions, as chief ionizing agents, shoot out from the anode, and the ionization they produce by their impact upon gaseous molecules is independent of the material of the anode. At the cathode, on the other hand, they produce ionization by impinging upon gaseous molecules attached to the cathode. Now, the proximity of a metal has the effect of reducing the "ionizing potential" of a molecule to an extent varying from one metal to another. Hence, in this case the material of the electrode is of importance. But it is marked if the cathode is in the least oxidized. Iron, nickel, silver and aluminum show a great variation of the negative discharge potential with their state of oxidation. Gold and platinum maintain a steady value.—*Phys. Zeit.*, August 1; abstracted in Lond. *Elec.*, August 15.

Mechanical Effect of Disruptive Discharge.—SEMENOV.—A description of certain mechanical effects of the electric spark, which shed some light upon the transportation of matter from one electrode to another. The experiments were conducted under ordinary atmospheric pressure, and he comes to the conclusion that, contrary to usual supposition, there is no transportation of the materials of either electrode though the transportation of the gas or vapor surrounding it is well marked, and gives rise to strong mechanical effects. The discharge from an induction coil was made to pass between a positive flame and a negative saline solution enclosed in a narrow tube, about 1 mm. in internal diameter. The matter transported by the positive discharge impinged violently upon the solution, and made it spurt out in a luminous jet several millimeters long, and in the direction in which rays would be reflected. The spurting consumes energy, and consequently the cathode is much less heated than would otherwise be the case. The projected liquid is not chemically altered. That the spurting was not due to impact of the material of the anode itself was proved by making the anode consist of a jet of copper sulphate solution. This produced the same spurting, but without any copper sulphate being transferred to the cathode, unless the jet was stopped and metallic vapor was formed by the heat then developed.—*Comptes Rendus*, July 21; abstracted in Lond. *Elec.*, August 8.

Dark Cathode Space.—WEHNELT.—Some results of measurements of free electric charges in the dark cathode space. The greatest amount of free positive electricity is found immediately at the cathode and at the outward limit of the dark cathode space. Between these there is a space having a surplus of negative ions. The cathode is concentrically surrounded by electric charges of different signs, but the algebraic sum of the whole free charges is always positive. This surplus of positive ions varies as the pressure of the gas and as the

current strength. Corresponding to the positive surplus in the gas is a negative charge on the cathode itself, whose discharge is facilitated by the ultraviolet light given out by the negative glow.—*Phys. Zeit.*, August 1; abstracted in Lond. *Elec.*, August 15.

Rotary Polarization.—LORD RAYLEIGH.—An investigation of the question whether the rotation of the plane of polarization of light propagated along the axis of a quartz crystal, is affected by the direction of this axis relatively to the earth's orbital motion. According to the theory of Lorentz, an effect of the first order might be looked for. According to Larmoor's theory, there should be no effect of the first order. Lord Rayleigh has found by experiments that the rotation is certainly not altered by the 1/100,000 part when the direction of propagation of the light is altered from that of the earth's motion to the opposite direction. This result supports the idea that the ether moves bodily with the earth, at least up to a certain height.—*Phil. Mag.*, August; abstracted in Lond. *Elec.*, August 15.

Zeeman Effect in Absorption Bands.—SCHMAUSS.—An account of some further measurements of the magnetic rotation of the plane of polarization within an absorption band, mainly in order to clear up some theoretical points raised by Voigt. He succeeded in verifying two of Voigt's theoretical conclusions, the first being that the maximum rotation in a field of absorption is nearly independent of the strength of field, and the other that the negative rotation in the interior of an absorption band diminishes with an increasing field. This diminution is convincing in the case of litmus and aniline blue, but not so marked as it is in didymium glass.—*Ann. d. Phys.*, No. 8; abstracted in Lond. *Elec.*, August 15.

Ionization by Ionic Shock.—STARK.—A theoretical discussion of the work of several investigations of the current in a gas and its dependence upon the e. m. f. His theory of ionization by ionic shock maintains that, in ionized gas, the current at first increases with the e. m. f. until all the ions generated in the gas, whether by Röntgen rays, ultraviolet light, incandescence, or other artificial means, are used up by the current as fast as they are generated. When this is the case, an increase of e. m. f. does not produce any further increase of current. But on further increasing the e. m. f. a point is reached at which the ions, traversing their mean free path, acquire a sufficient velocity to ionize neutral molecules by their impact. The current then becomes "independent," and rises again with increased e. m. f. The curve with the e. m. f., as abscissa, and the current, as ordinate, has, therefore, an ascending branch, a horizontal portion, and another ascending branch. Such curves may be obtained from the data provided by several investigators. In some cases the curves are not complete, as the point at which the independent current sets in depends upon the pressure, temperature and imparted ionization of the gas. "The positive ionizing potential is about 240 volts in air, with an aluminum electrode, and 270 volts with a copper electrode."—*Ann. d. Phys.*, No. 8; abstracted in Lond. *Elec.*, August 8.

Demagnetizing Effects of Electromagnetically Compensated Alternating Currents.—CROOK.—An account of an experimental investigation, the results of which are given in diagrams and tables. The "alternating current as magnetically compensated, has an effect on the magnetic induction in iron." For low-current densities (below 7.5 amperes per sq. mm.) the reduction by the residual magnetism in iron, or the reduction of the area of the hysteresis cycle, is proportional to the strength of the current. The effects of the alternating current on the residual magnetism in iron are different for different frequencies, that for the lower frequency being the greater. The total reducing effect is approximately proportional to the strength of the current.—*Am. Jour. Sc.*, August.

Radium.—MDE. CURIE.—An account of experiments in which she has succeeded in obtaining pure chloride of radium and has taken the opportunity for determining the atomic weight of radium. She is enabled to state definitely that it is 225 within a unit.—*Comptes Rendus*, July 21; abstracted in Lond. *Elec.*, August 8.

REFERENCES.

Magneto-Optic Effects.—VOIGT.—A review of recent discoveries of magneto-optic effects, with reference to his own theory. The investigations of Corbino, Zeeman and Majorann are dealt with.—*Ann. d. Phys.*, No. 8; abstracted in Lond. *Elec.*, August 8.

Magnetic Double Refraction.—MAJORANA.—A description of experiments, in which he has discovered an effect in magnetism, analogous to the Kerr effect in electrostatics. The particular effect described is a magnetic double refraction in solutions of ferric chloride and in colloidal iron oxide.—*Comptes Rendus*, July 24; abstracted in Lond. *Elec.*, August 8.

Screening Effect.—LEVI-CIVITA.—A highly mathematical paper on the screening effect of a conductor in a parallel alternating current.—*Accad. Lincei*, Feb. 16, March 2, 16; abstracted in *Science Abstracts*, July.

ELECTRO-CHEMISTRY AND BATTERIES.

Electrolysis of Alkali Salt Vapors.—WILSON.—An account of an experimental investigation of the passage of electricity through flames containing salt vapors. Former experiments have shown conclusively that conduction through salt-vapors is accomplished by means of ions of some kind and is, therefore, to this extent at least analogous to conductions through solutions. The experiments described in the present paper show conclusively that above 1,300° C. there is a very close analogy between salt vapors and liquid electrolytes; Faraday's laws of electrolysis are strictly applicable to salt vapors, just as to salt solutions. He shows that a salt in the state of vapor gives rise to the same number of ions carrying the same charges as a salt in an aqueous solution. He describes in detail the arrangement of his experiments, and gives in a diagram curves showing how the current with a constant e. m. f. (840 volts) varies with the temperature when solutions of one gram in a litre are sprayed. The nearly constant value of the current above 1,300 degrees seems to represent the maximum current which the amount of salt passing through the tube can carry, for it is affected very little by increasing either the temperature or e. m. f. This current he calls the "saturation" current for the particular salt used. The values of this maximum current are given for various salts in a table. From this table he proves that Faraday's laws of electrolysis apply also to the saturation current carried by a salt vapor. The amount of salt per second of electrochemical equivalent unity which would correspond to a current of 1 ampere is 0.0101 milligram. Now, 1 ampere-second liberates in electrolysis 0.0104 milligram of hydrogen, so that it appears that the factor of proportionality is nearly the same for salt vapors as for electrolytes.—*Phil. Mag.*, August.

REFERENCE.

Unipolar Currents.—CHRISTIANSEN.—A paper on a peculiar apparent departure from Ohm's law, observed in certain electrolytes. He applies the term unipolar current to the current through mercurous nitrate in nitric acid, with mercury electrodes, because this current greatly depends upon the size of the cathode, and not on the size of the anode. The irregularity observed is that under certain conditions the current is independent of the e. m. f. It varies, however, directly as the surface of the cathode and as the percentage of mercurous nitrate.—*Ann. d. Phys.*, No. 8; abstracted in Lond. *Elec.*, August 8.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Speed Indicator.—An illustrated description of an electric speed indicator, brought out by an English company to comply with the Board of Trade regulation that every electric tramcar shall be fitted with a speed indicator. It consists essentially of a small magneto-generator, attached direct to the motor-frame, and two indicating instrument, one on each platform. These instruments are small voltmeters, and are calibrated in revolutions per minute, the voltage of the small generator being directly proportional to the speed. The recorders are placed on a special "anti-vibration" frame.—Lond. *Elec.*, August 22.

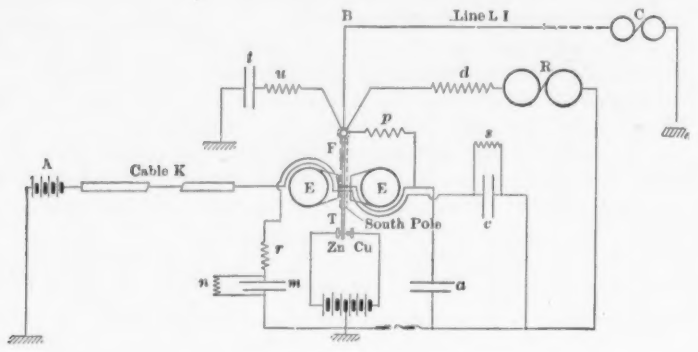
REFERENCE.

Galvanometer.—WRIGHT.—An illustrated article on the development of the principle present types of galvanometers, with a general outline of their various constructional principles.—*Cassier's Mag.*, September.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Vibrating Cable Relay.—GULSTAD.—The first part of an illustrated article on his cable relay, which is said to have been used for years in connection with some of the cables of the Great Northern Telegraph Company, and to have given most favorable results. It is not so much the specially constructed polarized relay for Morse signalling, but more especially an arrangement of condensers and resistances in connection with it, which is said to be the feature of the system. The adjoining diagram shows the essential parts of the relay arrangement used in connection with the cables from England to

Sweden. *A* is the cable station, *B* the translating station, and *C* the receiving station. At the translating station there are, *E* the electromagnets of the relay, *F* the armature of the relay, *T* the tongue of the relay, *Zn* and *Cu* the zinc and copper poles of the relay, *c* a condenser, *s* a resistance belonging to the cable circuit through one relay winding, *a* and *m* condensers belonging to the local relay circuit, *r*, *n* and *p* resistances belonging to the local relay circuit, *t* a condenser, *u* a resistance in connection with the tongue, *R* the receiving apparatus in the leak circuit, and *d* the resistance in the leak circuit. It will be seen that the armature and tongue will move



ARRANGEMENT OF RELAY.

toward the *Cu* or *Zu* pole when a positive or negative current passes from *A* through the cable, and further that a current in the local circuit always tends to drive the tongue away from the contacts between which it is moving. The natural attraction between one or another of the pole-pieces and the relay-armature, may, when the relay is symmetrically adjusted, be easily and completely neutralized by giving *p* a proper size, *i. e.*, the relay can thereby be made as sensitive as required when acted upon by any current from the cable through the other winding. By further decreasing *p*, the tongue begins to vibrate, and the relay is preferably used in this condition. The rate of vibrations or dots may be regulated at will by variation of condensers and resistances in the local circuit, and the working rate generally is made equal, or almost equal, to the rate of dots emitted by the transmitter at *A*. Sparking, due to induction from the line between *B* and *C*, is avoided by the condenser *t*, connected with the tongue; but this very condenser may sometimes cause sparking and considerable contact-stickings; this drawback can, however, be completely overcome by the introduction of a small resistance, *u*. To make good contacts, the condenser *a* is important; for this purpose it is also necessary that the poles of the electromagnets should be very much closer to the armature than usual; and that the resistance, *p*, should be introduced. The current charging condenser, *a*, will then immediately cause the tongue to be pressed against the contact screw with which it has just made contact, and from which it is shortly afterwards repulsed.—Lond. *Elec. Rev.*, August 22.

Telephonic Receiver for Wireless Telegraphy.—Bleckrode.—A description of a very simple arrangement which is said to give excellent results. He fixes two parallel pieces of carbon, as used in an ordinary arc lamp, having a length of 5 cm., on a square piece of wood and makes with it a circuit including a couple of dry cells and a telephone; the circuit is completed by placing three or four common sewing needles loosely in transversal direction on the carbon rods. The apparatus is ready for use when the insulated wires of the signal mast is joined to one carbon, and the other is connected to the earth conductor. The letters from the Morse alphabet are very distinctly heard as shorter or longer taps in the telephone, and the telegrams are easily read by sound by a trained operator. He believes that such a receiver may prove very useful for temporary installations of wireless telegraphy, as anyone may carry it with all its accessories of his pocket and put it at once in action when an insulated wire can be fixed to some elevated post. He also investigated whether this arrangement is really anti-decohering; with the telephone no tapping is required, while a slight tapping is necessary when a sensible aperiodic galvanometer was substituted for the telephone. It may be that the self-induction of the coil of the telephone is sufficient for decohering, which factor is not as active when a galvanometer is substituted.—*Nature;* Lond. *Elec.*, August 15.

Telephony.—An editorial on recent developments in telephony. Reference is made to the recently published financial reports of the two British pioneer municipal telephone systems at Glasgow and Tunbridge Wells. In Glasgow the conditions were extremely favorable; but while it is not surprising that in the first year the undertaking was practically working at a loss, it is doubtful whether it will pay in the future. People in favor of municipal telephony are urged "to study carefully the Glasgow and also the Tunbridge Wells accounts before risking their taxpayers' money on the experiment of competitive telephony." The suitability of the call-wire system at Glasgow is doubted. For the common battery system it is claimed that for quick, efficient and economical working it is second to none, but its first cost must not be forgotten; and it is doubted whether it is suitable for small exchanges.—Lond. *Elec.*, August 15.

REFERENCE.

Common-Battery System.—Grace.—An illustrated article on the common-battery system for small exchanges.—*Telephony*, August.

Miscellaneous.

Electric Production of Sleep.—Leduc.—A description of a method of producing sleep and local anæsthesia by means of electric currents. Continuous current is used, from an accumulator, with a small resistance in the circuit. A non-inductive interrupter, giving 150 to 200 breaks per second, is inserted in the circuit. A moist electrode is placed on the animal's shaven head and another on the back near the tail. The e. m. f. is rapidly increased till the animal shows generalized contraction, and respiration is stopped. The current is then reduced to about 5 milliamperes, with 12 to 30 volts. Respiration then sets in again and the animal sleeps a profound and tranquil sleep. It lasts as long as the current is continued. "As soon as it stops, the animal wakes up and jumps about with every sign of delight, and no evil consequences appear to result." If the current is not first brought to the point at which respiration stops, some agitation is displayed, such as seen in the administration of chloroform. A smiliar current applied to the root of a human nerve, such as the median of the wrist, gives rise to complete anæsthesia of the region innervated, accompanied by a prickling sensation, which is not painful.—*Comptes Rendus*, July 21; abstracted in Lond. *Elec.*, August 15.

India.—An article on India as a field for electrical enterprise. Madras has an electric tramway but no public lighting system. In Bombay there is a large scheme for spending $5,000,000 in both tramways and lighting. The two principal power schemes are those on the Cauvery Falls and at the Coonoor Cordite Factory. Neither has yet started work, but the first one will start soon; the whole of its electrical plant is of American manufacture; its prospects are exceptionally good, as it will have a continuous load 24 hours a day and 365 days of the year, supplying the Mysore Gold Fields with power, and working continuously without intermission. There is said to be a field in India for installing isolated electrical plants in clubs, mills and factories.—Lond. *Elec. Rev.*, August 15.

REFERENCES.

British Manufacturing Plant.—An illustrated description of the "Arc" Works, Chelmsford, with description and results of tests of an 800-kw multipolar generator.—Lond. *Elec.*, August 15.

Influence Machine.—Allen.—An article on a large influence machine of the Winshurst type, built for the Royal Infirmary, at Glasgow. Its construction is described and illustrated.—Lond. *Elec. Rev.*, August 15.

Modern Machine Methods.—Orcutt.—The first part of an illustrated paper, read before the Brit. Inst. of Mech. Eng. In this part he discusses gauges, light milling, circular milling, heavy milling, planing, grinding, chucking, turning and polishing.—Lond. *Elec.*, August 15.

New Books.

Submarine Warfare. By Herbert C. Fyfe. New York: E. P. Dutton & Co. Cloth, octavo. 1902. 332 pages, 50 illustrations. Price, $3.00 net.

Submarine warfare is rapidly accumulating a literature of its own, but as pointed out by the author of this interesting volume there has hitherto existed no popular work in the English language on submarine warfare, and only one which deals exclusively with submarine boats. Indeed, the subject is still so new in many of its aspects that no hesitation is exhibited in this volume in devoting several chapters to the morality, the romance and the picturesqueness of warfare waged under the waves; and hence we have the sociolog ical and metaphysical sides of the art discussed with a good deal

of animation. Mr. Fyfe seems, indeed, to take umbrage, more or less openly expressed, at the general indifference of his countrymen to submarine boats, as contrasted with the lively interest of the gallant nation on the south side of the English Channel. It is true that the fogs and the rough seas around the tight little island have long done much to stand off any possible invader, and it may, of course, be equally true that the murky dirtiness of the water also may in time be effective in preventing any submarine vessel from finding its unseen way through the palpable obscure—as Milton once put it. In America we have been rather more alert in the matter, and wisely so, with no fleet in particular, worthless forts, and a long, lone coastline.

Mr. Fyfe does ample justice, indeed, to American invention and enterprise in this field, going back to Fulton and Bushnell, giving the history of notable efforts in the civil war, and including the latest work of Holland and of Lake. While cast intentionally and avowedly in popular form, the book is full of technical data, is admirably illustrated, and excellently got up on the whole. We believe it will find many readers in America.

HANDBOOK OF ELECTRICAL MACHINERY AND APPARATUS. By Geo. L. Anderson, A. M. New York: D. Van Nostrand Company. 161 pages, 214 illustrations. Price, $3.00.

The title of this book as above set forth is somewhat misleading, as it is not intended to be of general application. On the title page the inscription reads, "A Hand Book for the Use of Electricians in the Operation and Care of Electrical Machinery and Apparatus of the U. S. Coast Defenses," which more correctly defines its scope.

It is evidently a compilation of the instructions issued to the civilian and enlisted attendants of the electrical apparatus used by the Army Department in the various fortifications, and is rich in illustrations, a particularly commendable feature being the various diagrams showing the connection of switchboards, rheostats, searchlights, telephone apparatus, etc., of the standard types employed.

The apparent bodily abstraction of directions has resulted in useless reiteration at several points, notably in the direction for the erection and care of storage batteries, and has resulted in making the book hard to read, the sentences being entirely disconnected.

The various chapters into which the book is divided treat of the handling and care of boilers, of steam engines, the Hornsby-Akroyd oil engine that the army uses so extensively, switchboards, storage batteries, motors, projectors, the Ardois night signals, telegraphy and telephony. There is also a chapter on simple testing and one giving the requirements on which the standard specifications are based.

It is rather surprising to note that the Ward Leonard system of motor control which is finding great favor in the sister branch of the service, and which bids fair to come into extensive use by the army also, should have alloted to it less than one-fourth page. It would seem to be of sufficient importance to receive more extended mention.

While it is, of course, easy to find points open to adverse criticism, such as the directions that a motor should be stopped by first cutting in the starting rheostat and then opening the main switch, and that a bar-to-bar test of an armature should be made with a portable voltmeter, the work taken as a whole is thoroughly good. As an example there might be mentioned the brief paragraph setting forth the derangements to which telephonic apparatus is subject, a list which while not perfect is one with whose aid any electrician of ordinary intelligence should be able to promptly put in order or at least locate the point of trouble in ninety-nine out of a hundred faulty telephones.

While the work is primarily intended to apply to government apparatus and installations, it is one which every owner of an isolated plant, particularly one in which storage batteries are present, could place in the hands of his electrician to their great mutual advantage. Those following correspondence school instruction would likewise find it an undoubted aid, particularly because of the numerous practical hints that it gives.

BOOKS RECEIVED.

ELEMENTARE VORLESUNGEN UBER TELEGRAPHIE UND TELEPHONIE. By Richard Heilbrun. Berlin: Georg Siemens. 64 pages, 44 illustrations.

DIE GEWINNUN DES ALUMINIUMS. By Adolphe Minet. Halle: Wilhelm Knapp. 130 pages, 57 illustrations, 15 tables. Price, 7 marks.

Directory of Electrical Societies, Etc.

AMERICAN ELECTROCHEMICAL SOCIETY, Secretary, C. J. Reed, Philadelphia, Pa. Next meeting, Niagara Falls, N. Y., Sept. 15, 16 and 17, 1902.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Secretary, Ralph W. Pope, 95 Liberty Street, New York. Next meeting, Sept. 26. Paper by B. G. Lamme, "The Washington, Baltimore and Annapolis Single-Phase Railway." Oct. 24, paper by C. P. Matthews on "An Integrating Photometer for Glow Lamp and Sources of Like Intensity."

AMERICAN STREET RAILWAY ASSOCIATION, Secretary, T. C. Penington, 2020 State Street, Chicago, Ill. Next meeting, Detroit, Mich., Oct. 8, 9 and 10, 1902.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, W. H. Johnson, Philadelphia, Pa.

CANADIAN ELECTRICAL ASSOCIATION, Secretary, C. H. Mortimer, Toronto, Ont. Next meeting, Toronto, Ont., 1903.

INDIANA ELECTRICAL ASSOCIATION, Secretary, Hal. C. Kimbrough, Muncie, Ind. Next meeting, Indianapolis, Sept. 17 and 18, 1902.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS, Secretary, Frank P. Foster, Corning, N. Y. Next meeting, Richmond, Va., Oct. 7, 8 and 9, 1902.

NATIONAL ELECTRIC LIGHT ASSOCIATION, Secretary, James B. Cahoon, 136 Liberty Street, New York. Next meeting, Chicago, May, 1903.

NORTHWESTERN ELECTRICAL ASSOCIATION, Secretary, Thos. R. Mercein, Milwaukee, Wis.

OHIO ELECTRIC LIGHT ASSOCIATION, Secretary, J. H. Perkins, Youngstown, Ohio. Next meeting, Columbus, Oct. 14, 15 and 16, 1902.

OLD-TIME TELEGRAPHERS' AND HISTORICAL ASSOCIATION, Secretary, John Brant, 195 Broadway, New York.

PENNSYLVANIA STATE STREET RAILWAY ASSOCIATION, Secretary, John Ruth.

U. S. MILITARY TELEGRAPH CORPS, Secretary J. E. Pettit, Postal Telegraph Company, Chicago, Ill.

VERMONT ELECTRICAL ASSOCIATION, Secretary, C. C. Wells, Middlebury, Vt.

De Forest Wireless Telegraph System in the War Manoeuvres.

Whatever may be the ultimate outcome of the recent Army and Navy manœuvres, so far as the relative efficiency of the two branches of the service is concerned, they have very clearly demonstrated the great utility of wireless telegraphy. The Army appears to have thoroughly appreciated the important role that wireless telegraphy could be made to play, for it made arrangements for the use of three different systems, the Marconi, the De Forest and the Fessendcn. Should the decision of the umpires be in favor of the Army, there is little doubt it will be largely due to the assistance which the Army derived from wireless communications. By its means on several occasions the shore defences were kept informed of the movements of the attacking fleet long before it could have been sighted; and doubtless the strategy on the part of the Navy was circumscribed through the lack of wireless communication with the different portions of the fleet.

The U. S. Signal Corps installed two sets of De Forest apparatus, one at Ft. Mansfield and the other on board the scout-boat, "Unique." These two sets were in working order a week before the manœuvres began, and continued to give uninterrupted service up to Saturday noon, September 6, the end of the manœuvres. During this time the distance varied from five to fifty miles, but throughout, and under all conditions of weather, the system was in complete operation.

During the week of the manœuvres 72 official messages were transmitted from boat to shore, beginning at midnight, Sunday, August 31; from that time on the "Unique" kept in constant touch with the movements of the enemy's fleet, and the De Forest operators at Ft. Mansfield were continually in touch with them. These scout messages were transmitted by telephone to Col. Davis, at the headquarters of the firing district at Ft. Wright; to General Greely,

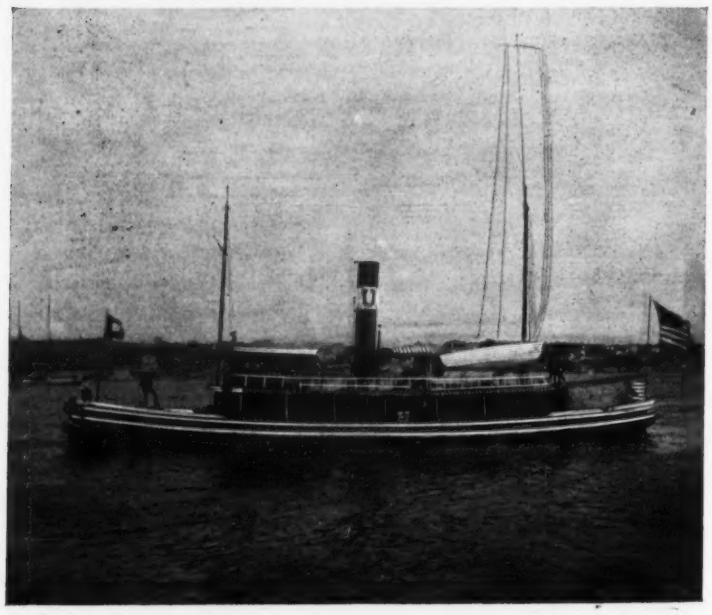
Chief Signal Officer, U. S. A., and to General MacArthur at New London, and the operation of the batteries at the different forts was largely governed by these "Aerograms."

All in all, 95 per cent. of the messages transmitted were perfectly received at the receiving station. The longest distance transmitted was on Thursday, September 4, when one of the operators in charge of the Fessenden apparatus on board a tug-boat in Narrangansett Bay sent the following message, at the rate of 40 words per minute: "Now is the time for all good men to come to the support of their party."

Though unexpected this was received perfectly by the operator with the De Forest apparatus at Ft. Mansfield, and later verified by comparison with the Fessenden operators. The distance was between 50 and 60 miles, and, inasmuch as the tug-boat's mast was but 40 feet in height, the performance was a most remarkable one, both for distance and speed.

The apparatus at Ft. Mansfield and on board the scout-boat "Unique" was identical; the sending apparatus included a small kerosene engine belted to an alternating-current generator, transformer, condenser and key. The antenna on board the boat consisted of three parallel stranded wires, 65 feet in height. That at Ft. Mansfield was similar, and was hung from an 80-foot mast. The average speed of word transmission throughout the manœuvres was 20 words per minute, no code or abbreviations being used.

The De Forest operators on board the scout-boat "Unique" had



SCOUT-BOAT "UNIQUE."

a most exciting week of it. On three separate occasions the boat was constructively captured, sunk or completely destroyed by broadsides from the battleships. The Navy soon learned that this innocent-looking tug-boat had on board her apparatus of a nature most damaging to their plans, and were continually on the lookout for her. On Wednesday night, during a dense fog, the battleship "Brooklyn," showing no lights, suddenly loomed up not 100 yards away from the tug. The "Unique" instantly showed her heels and began to send forth "Aerograms" announcing the discovery of the fleet and the pursuit. The "Brooklyn" turned and gave her her full broadside at point-blank range, nearly knocking the "Unique" out of the water with the concussion. Not content with this the big battleship gave chase, and, turning, delivered her starboard broadside into the scout-boat. The captain, however, did not regard the wireless outfit as constructively injured, and continued throughout the night to inform the Army officers of the movements of the fleet.

On another night a severe storm was encountered, and the boat very nearly foundered. The topmast holding the aerial wires was swept overboard, and the kenosene engine and dynamo on deck was drenched with sea water, which put the wireless outfit *hors de combat* for a few hours.

So well pleased with the service are the Signal Corps officers that the station at Ft. Mansfield is to be permanently established there, and the set from the scout-boat will be stationed at some Army post in the neighborhood, probably at Ft. Wetherill. This will mean a range of some 50 miles, mostly over land, and will be the first of a number of wireless installations at the various artillery districts of the United States Army.

The service altogether was so satisfactory as to leave no doubt in the minds of the Army officials as to the necessity of wireless telegraphy in war manœuvres, at least where conducted near the seacoast. In all other nations the Navy has been first to adopt wireless telegraphy, and it is significant of the enterprise and progressive spirit of our Army, and notably of the efficient Signal Corps, that it has remained for them to demonstrate to the Navy the usefulness of this new adjunct in warfare. It will be remembered that only last week Admiral Higginson put in an urgent appeal for wireless telegraphy for the Navy, and in view of the remarkable success of the De Forest system during the manœuvres, it is to be expected that the naval officers will give this system a thorough trial in the near future.

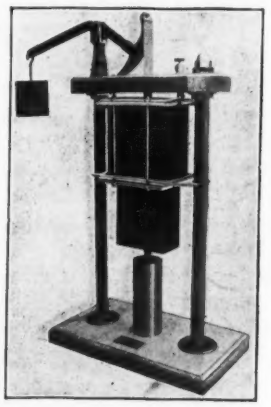
The accompanying cut shows the U. S. Signal Corps' scout-boat "Unique," equipped with a high mast with three pendant wires, which was used by the De Forest system throughout the manœuvres.

G. I. Series Alternating Current Lighting System.

The accompanying illustration shows the automatic regulator used in the alternating constant-current series system of the General Incandescent Arc Light Company. A pair of reactive coils is mounted in a metal frame and supported by spiral springs from a heavy marble top. This top is supported by an iron frame which is secured to a similar marble base. A laminated iron core is suspended under the reactive coils in such a way that it can play up and down in the magnetic field of the coils.

To the lower part of the core is fastened a metal strip, which is attached to the upper face of the arc on one end of the lever which carries the adjustable counter-weight at its other end. Below the core, and fastened to it, is a large air-dash pot which prevents "pumping" of the system and aids the starting of the lamps. Suitable binding posts are mounted on the marble top, allowing the regulator coils to be connected in series with the lamp circuits.

When not in operation only a small portion of the legs of the laminated iron core are surrounded by the windings of the reactive coils. If the outside line is short-circuited and current turned on, the core is immediately drawn into coils, which then react against the line potential and keep the current constant at the value for which the regulator is adjusted. When the short-circuit is removed, causing the current on the circuit to fall, the core drops down; this decreases the reactance of the regulator, and sufficient of the line potential is allowed on the lamp circuit to start and operate the lamps. If one or more of the lamps are switched off or cut out, causing the current on the circuit to increase, the regulator coils attract the core, which when entering the coils, further increases the reactance of the regulator, and the current will again be brought to its given value.



AUTOMATIC REGULATOR.

From the above it will be seen that the current on the circuit is inclined to vary with the changes of load on the lamp circuit, but the regulator coils being in series with the circuit of lamps and the core moving up or down with the slightest change of current, the automatically changing reactance of the regulator coils will always give the proper voltage and current to the lamps, no matter how many may be burning, as long as the voltage at the terminals of the constant potential alternating circuit furnishes not less than the required voltage (83) per lamp.

The regulator has no moving wires or coils, and therefore all trouble due to broken leads and loose connections is obviated. The efficiency of a 50-light regulator is about 98.6 per cent., and the current regulation from no load to full load is within .2 ampere. The current adjustment is by means of counter-weight, from 6 to 7 amperes.

In this alternating system for arc and incandescent lamps the series circuit may be connected either directly to the primary constant-potential circuit, or to the secondary of a constant-potential transformer. If the supply is direct from the current, the lamp circuit is connected, through suitable safety devices, to the primary bus-bars which are supplied direct from the generator, in which case the potential of the generator must allow not less than 83 volts per lamp, including regulator and line. The usual potential of alternators for ordinary city lighting is from 1,000 to 2,200 volts, on which the size of each arc-light circuit would be comparatively small. The higher voltage named would limit the lamps in a series to 26.

If the desired number of lamps to be operated in series on each circuit is greater than 25 or 26, it then becomes necessary to use a secondary source of supply. This is obtained from the secondary winding of constant-potential, step-up transformer, which is connected between the primary supply and the arc circuit. The application of a step-up transformer permits of transforming a low primary pressure to the necessary pressure for a large number of lamps in series. A further advantage of using a transformer between the generator and each lamp circuit is that it prevents any disturbance in the primary part of the system if one of the arc circuits should become grounded. If, however, the construction of the arc circuits is first-class, and care is taken to prevent their grounding, the installation of transformers between the generator and each lamp circuit is not absolutely necessary, where the primary voltage is sufficient for the number of lamps desired in a series.

Carriage-Call Annunciator.

A new electric carriage-call annunciator, for both day and night use, has been brought out by Messrs. Edwards & Company, New York. The apparatus is designed to set on brackets attached to the side of a building or in any other proper location, and is constructed so as to show numbers on both sides. It consists of 6 five-sided lanterns, three on each side of the case. The lanterns can be made with a greater number of sides or a greater number of lanterns may be used to give as many numbers as desired. The numbers on each of the faces of the lanterns are of opal glass so as to be plainly visible in the day time, while for night use, a 32-cp lamp is suspended in each lantern, thus illuminating the figures.

FIG. 1.—CARRIAGE-CALL ANNUNCIATOR.

The annunciator is operated by a 15-section switchboard of simple construction, there being three divisions of five numbers each, 5 for units, 5 for tens and 5 for hundreds, corresponding with the numbers 0, 1, 2, 3 and 4 on each lantern. From these 125 combinations can be made. The switchboard contains a switch for each number on each lantern, so that there are as many switches as there are numbers. By throwing in any switch, the corresponding number appears on the proper lantern. The switchboard is arranged with three rows of four switches each, one row for each of the three pairs of lanterns. If, for instance, the number 234 is displayed, the No. 2 switch in the first row, No. 3 switch in the second row, and No. 4 switch in the third row are closed. If, now, it should be desired to display the number 423, the No. 4 switch in the first row, No. 2 in the second

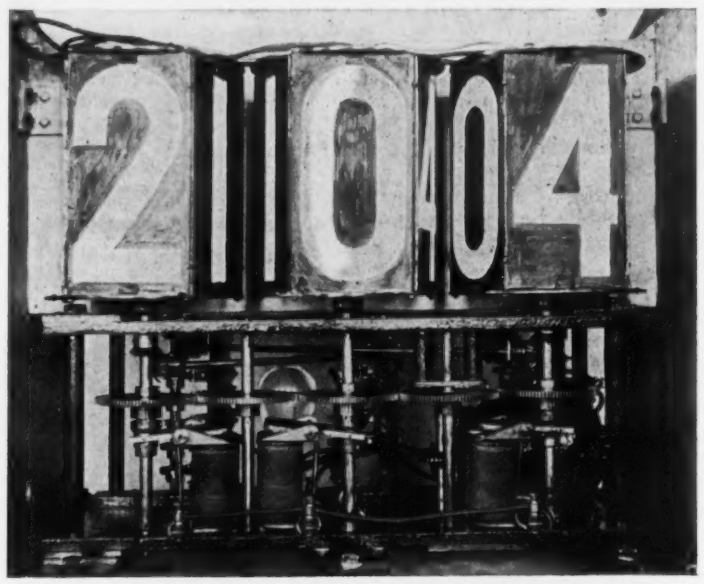


FIG. 2.—GEARS AND MAGNETIC CLUTCHES.

and No. 3 in the third would be thrown in, and the other switches that were last in would be opened.

The operation of the instrument is as follows: When the desired combination of numbers is switched in, the lanterns of both sides revolve to the desired numbers, and are automatically cut out in the instrument, the movement being given by a $^1/_{16}$-hp electric motor. Each section is provided with an electromagnetic clutch, which engages the lanterns the instant the circuit is established, and releases them when the circuit is broken. The lanterns are connected by mitre gear, so that each side will operate in unison with the other. The switchboard is provided with a main annunciator-switch, also one for the lights.

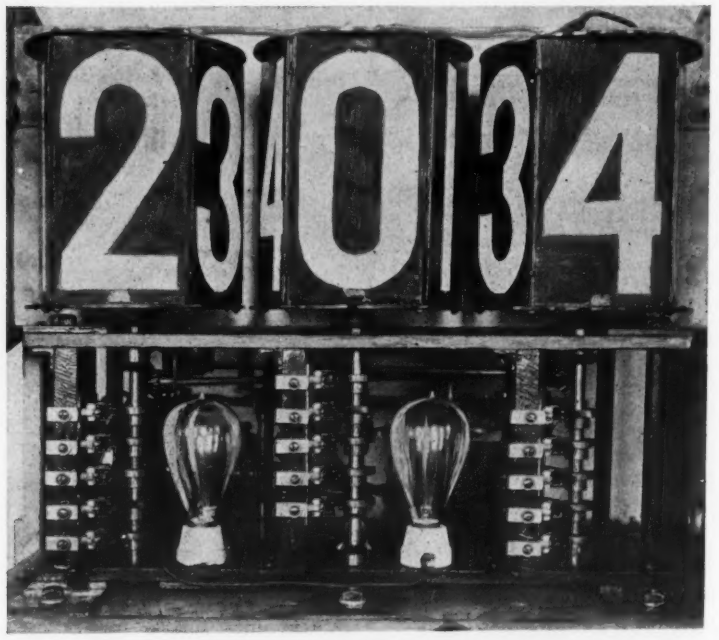


FIG. 3.—SHUNT LAMPS AND SWITCHES.

In the accompanying illustrations, Fig. 1 shows the annunciator complete, encased in an ornamental box; Fig. 2 shows the arrangement of gears and magnetic clutches, and Fig. 3 the arrangement of shunt lamps and automatic switches. One of these annunciators is in practical operation at the store of Stern Brothers, on Twenty-third Street, New York, and is said to be working satisfactorily.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Time money was in small supply and quoted at 5 per cent. for all periods. Commercial paper was very dull. Higher rates for call money checked the tendency of the speculative stock market to expand, and the consequence was that the principal stocks receded. The United States Steel stocks were stronger on interested support and favorable news as to earnings. The Gould stocks were active and strong, Manhattan being favorably influenced by the increase of $700,000 in the net earnings for the year ending June 30. Amalgamated Copper showed some strength and rose to 70 on favorable reports as to copper trade conditions. Brooklyn Rapid Transit showed more activity, reaching 71⅛ and closing at 70¾, a net gain of 3 points; the lowest figure being 68. Met. St. Ry. fluctuated between narrow limits on small trading; the range of prices being 147, the lowest, and 149½ the highest, closing at 148. General Electric closed weak at 193½, being 4 points below the highest quotation of the week, and only ½ point above the lowest; the closing price representing a net loss of 2½ points. Western Union closed at 94¾, a net loss of ¾ point; Westinghouse common, 226, the lowest quotation of the week, 230 being the highest, the net loss being 2 points. Westinghouse 1st preferred kept steady at 230¼, being ¼ of a point net increase. The closing prices of other stocks were: American District Telegraph, 36¾, being a net loss of 2¼ points, and American Telephone and Telegraph, 172, a net loss of ½ point. Outside securities were generally higher, but with many recessions from the top figures. More attention was given to copper stocks. Following are the closing quotations of September 9:

NEW YORK.

	Sept. 2.	Sept. 9.		Sept. 2.	Sept. 9.
American Tel. & Cable.	94	—	General Electric	196½	195
American Tel. & Tel..	—	171½	Hudson River Tel.	—	—
American Dist. Tel.	—	—	Metropolitan St. Ry.	147½	147¾
Brooklyn Rapid Transit.	68¼	71	N. E. Elec. Veh. Trns.	¾	1
Commercial Cable	—	174½	N. Y. & N. J. Tel.	—	—
Electric Boat	25	25	N. Y. E. V. T. Co.	—	11½
Electric Boat pfd.	40	40⅛*	Tel. & Tel. Co. Am.	—	—
Electric Lead Reduc'n..	2½	2⅜	Western Union Tel.	95½	96⅛
Electric Vehicle	5½	5¾	West. E. & M. Co.	229½	—
Electric Vehicle pfd.	14½	15¼	West. E. & M. Co. pfd.	230¼	—

BOSTON.

	Sept. 2.	Sept. 9.		Sept. 2.	Sept. 9.
American Tel. & Tel.	171½	171	Western Tel. & Tel. pfd.	100½	100½
Cumberland Telephone .	—	—	Mexican Telephone	2¼	2¼
Edison Elec. Illum.	—	—	New Eng. Telephone	143½	142
Erie Telephone	—	—	Westinghouse Elec.	113½	—
Western Tel. & Tel.	—	29¼	Westinghouse Elec. pfd.	115	—

PHILADELPHIA.

	Sept. 2.	Sept. 9.		Sept. 2.	Sept. 9.
American Railways	51⅜	53	Phila. Traction	100	100
Elec. Storage Battery..	88	89½	Phila. Electric	8⅝	9 1/16
Elec. Storage Bat'y pfd.	—	88½	Pa. Elec. Vehicle	—	—
Elec. Co. of America..	9¼	9⅜	Pa. Elec. Vehicle pfd..	—	—

CHICAGO.

	Sept. 2.	Sept. 9.		Sept. 2.	Sept. 9.
Central Union Tel.	—	—	National Carbon pfd.	99¾	100
Chicago Edison	173	—	Northwest Elev. com.	36½	—
Chicago City Ry.	—	222*	Union Traction	—	18¾
Chicago Tel. Co.	175	—	Union Traction pfd.	—	50
National Carbon	32½	34*			

* Asked.

LIGHTING CONSOLIDATION AT WASHINGTON.—The United States Electric Lighting Company, of Washington, is to be absorbed by the Potomac Electric Power Company. At a meeting last week of the stockholders of the two companies the deal for the purchase of the United States Electric Lighting Company by the Potomac Electric Power Company was consummated. The sale will take effect September 30. The charter of the United States Electric Lighting Company, under the laws of West Virginia, will expire on October 1, the transfer being, therefore, on the last day of the corporate existence of the company. The interests which control the company are identical with those controlling the Potomac Company, and the companies have practically been one since the merger of electric lighting and street railway interests. The debenture bonds and certificates of indebtedness of the United States Electric Lighting Company are secured by mortgage upon the property of the United States Company. The floating debt and contracts of the United States Company are assured by the Potomac Company, which will fund all floating debt. To do this, a mortgage of $2,500,000 will be laid, according to the plans of the company, and the present debt of $650,000 be retired. The consideration paid for the United States Company's property is $3,250,000 of the stock of the Potomac Electric Power Company. The Potomac Electric Power Company has filed with the recorder of deeds a certificate of reorganization. The paid-in capital stock is increased from $1,000,000 to $5,000,000, divided into shares of $100 each. It is stated that the liabilities of the company are $886,671.

OTIS ELEVATOR STOCK INCREASE.—At a special meeting of the Otis Elevator stockholders, held at East Orange, N. J., last week, it was voted to increase the preferred stock $2,000,000. About 85 per cent. of each class of stock voted in favor of the proposition. Of the new stock there will be offered to stockholders $1,090,000. Both preferred and common stockholders shall have the right to purchase at par an amount equal to 10 per cent. of their respective holdings. The balance will remain in the treasury to be issued as necessities may require. It is probable that both the preferred and common books will close September 25, and stockholders of record on that date will have the privilege of subscribing for the new stock.

DIVIDENDS.—The Manhattan Elevated directors have declared the regular quarterly dividend of 1 per cent., payable October 1. The Western Union executive committee has recommended the declaration of the regular quarterly dividend of 1¼ per cent. Otis Elevator directors have declared the regular quarterly dividend of 1½ per cent. on the preferred stock, payable October 15. West Jersey and Seashore directors have declared the regular semi-annual dividend of 2½ per cent., payable September 15. A dividend of 2½ per cent. will be paid on the preferred stock of Union Traction of Indiana October 1.

BELL TELEPHONE RIGHTS.—It is generally the rule with corporations which issue new stock from time to time, that, if stockholders neglect to take advantage of any rights in connection with their stockholdings the company benefits by such neglect. The American Telephone and Telegraph Company has, however, just sent a letter to stockholders who neglected to subscribe to the stock issue of June, or sell their rights, to the effect that the directors had authorized a payment of $15 per share to such stockholders, and checks were enclosed.

NEW ENGLAND ELECTRIC VEHICLE.—Trustees of the New England Electric Vehicle Transportation Company have declared a dividend in dissolution of $1 per share, calling for the payment of $223,550, payable September 15.

Commercial Intelligence.

THE WEEK IN TRADE.—Reports received by the mercantile agencies indicate that the past week was essentially one of active buying in distributive trade. Reports as to August trade have been almost uniformly favorable, while the business failures have been confined to a low summer minimum. Jobbing activity is undiminished at the West, Northwest and Southwest, and is of satisfactory volume at the East. The fuel shortage is pressing on the iron furnaces, and now the scarcity of cars and motive power is affecting the movement of ore from the lake ports to the Pittsburg district. Heavy imports of foreign iron and steel have cut down the premium on immediate-delivery business, but in the scarcity of supplies of domestic no particular interest is taken in this. Sales of foreign-made material are very large. In finished products, business in rails, bars and sheets is fair, and mills are heavily sold ahead. The business failures for the week ending September 4, as reported by *Bradstreet's*, aggregated 133, as against 140 the week previous, and 169 the same week last year. Copper continues weak, and prices have declined. Lake is quoted at 11.30 to 11.60c. for spot to September delivery; 11.25 to 11.55c. for October to December; electrolytic and casting, spot to December, 11.20 to 11.35c., and standard, spot to December, 10.70 to 11.15c., on 'change. Statistics compiled by Mr. C. Mayer, secretary of the New York Metal Exchange, show a total importation of 11,469 tons of copper during the month of August.

ELECTRIC TRACTION FOR MONTEREY.—A project is now under way, according to Mexican advices just received, with a view to the conversion of the two principal horse tramways in the city of Monterey, and the construction of a new electric line for which a concession has been acquired by the American engineering and contracting firm of MacKin & Dillon, of Monterey. The horse lines referred to are about 12 miles in length. The new electric line will be about 20 miles long. The scheme will in all probability be financed by a Wall Street banking house.

MEXICAN PLANT TO BE ENLARGED.—The Monterey Electric Light and Power Company, of Monterey, Mexico, is to considerably enlarge its plant. The existing equipment has a capacity of 800 hp. The generators are of General Electric, old Thomson-Houston, Stanley and Warren-Medbery build. The engines were furnished by McIntosh, Seymour & Co., Ide, and Armington & Sims. The boilers are from the Trenton Boiler Works and the Springfield Boiler Manufacturing Company. It is now proposed to increase the plant up to 2,000 hp, while eventually the capacity of the plant will reach 4,000 hp. It is expected that a producer gas plant will be installed, the units to be 500 hp each. Steam turbines may also be utilized. M. Emilio Dysterud, the electrical engineer of the company, as mentioned in our personal column last issue, is now in the United States regarding the matter, and is making his headquarters at the offices in the Washington Life Building of the Federal Electric Company. He will visit Boston. He will also visit Montreal, Niagara Falls, Chicago, St. Louis, Pittsburg, Schenectady and Hartford, and will be in this country about two months. The Monterey company is chiefly controlled by two Philadelphians, Joseph R. Livesey, Girard Building, and William Hopple, of the same address.

PNEUMATIC TUBE SERVICE.—The Post Office Department has closed a contract with the New York Mail and Newspaper Transportation Company for pneumatic tube service for postal matter over the old lines that were in operation from 1897 to 1900, when they were discontinued owing to the failure of Congress to appropriate for them. The mileage covered by this contract will embrace the line from the New York General Post Office to Branch P, .77 of a mile from the General Post Office, via Branch D, the Madison Square Station, to Station F, a distance of 4.41 miles, and from the New York General Post Office to the Brooklyn General Post Office, a distance of 1.65 miles. The price paid by the department is $15,799 per mile per annum. The service is to begin October 1, but may be put in operation a little earlier. The price is pro rata on the general bid made by the company recently for the whole general system proposed to be introduced as soon as Congress can be persuaded, from the efficiency of the service, to authorize it. The contract runs for one year, and contains a provision that either party to it may on a month's notice withdraw. The whole system will be planned for 8-inch carriers, as the old tubes are of this diameter.

BERRY ELECTRIC AND MANUFACTURING COMPANY has been formed at St. Joseph, Mo., under the laws of Missouri, with a capital stock of $10,000. Mr. G. D. Berry is the president and Mr. F. C. Uhlman is the secretary and treasurer. The company will do a general jobbing business, construct private lighting and telephone lines and plants, and also push the dynamo and motor trade in the St. Joseph territory, the city itself having a population of 102,987. Mr. G. D. Berry, who is the manager, was for 15 years purchasing agent for the St. Joseph and G. I. Railway. Mr. D. D. Berry, electrician, was in the Westinghouse factory for three years as a student, etc., and worked for about a year with the Geo. A. Fuller Construction Company. Mr. F. W. Mackey, formerly local manager for the Bell Telephone Company, has charge of the telephone department, which will push the undeveloped business of inter-communicating systems and rural lines.

ELECTRIC CARRIAGE-CALL SYSTEM.—Several contracts have recently been made by the Electric Carriage-Call Co., of 1402 Broadway, New York, which is now installing its system at the Metropolitan Opera House, New York, six boxes; Wallack's Theatre, New York, two; Providence, R. I., Opera House, one; Star Theatre, Buffalo, N. Y., one; Williswood Theatre, Kansas City, Mo., one; Garrick's Theatre, Philadelphia, one; San Francisco, Calif., one; and one for the exhibition room of the Boston Edison Company. The system was thoroughly investigated by the directors of the Metropolitan Opera House, who saw it in operation at the Herald Square and Criterion Theatres. A recent order is from Belasco's new theatre on Forty-second Street, New York City; and the system will be used this winter at Madison Square Garden for the Horse Show and other events. The company is looking for agents in the various unrepresented cities.

THE UNIVERSITY OF ILLINOIS has taken advantage of the perfection of the 220-volt incandescent lamp and the recent revision of the National Electrical Code of the Fire Underwriters, permitting the use of 500-volt distribution within buildings, by installing a 440-volt plant for the lighting of the five new buildings at Champaign. Two-phase alternating current will be used, and each phase will be treated as a single-phase circuit, operated on the three-wire system, the neutral wire being supplied with current from an auto-transformer. The exhaust from the steam engine plant operating the generators is to be used in heating the buildings. The generating station contains two-belted, two-phase generators, one of 50 kw and one of 75 kw, operated at 440 volts, to which will shortly be added an engine-type, revolving field, 120-kw alternator, purchased from the Westinghouse Electric and Manufacturing Company.

BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, has begun work on four direct-current generators for the Pittsburg Reduction Company, at Massena, N. Y., in connection with the work on which an article appeared in these columns last week. These generators will be of 2,200 kw each, 500 volts, 140 r. p. m., with double commutators; two generators on one water-wheel set. The present equipment at the St. Lawrence Power Company's plant is alternating current, but the Pittsburg Reduction Company uses direct current, and is, therefore, putting in this apparatus to avoid the conversion which would otherwise be necessary, as at Niagara.

WATER-POWER PLANT FOR RUSSIAN MINES.—The Caucasus Copper Company, of South Russia, through its engineer, J. Stanley James, who came to the United States for the purpose, has placed a contract for a 500-hp hydraulic plant, which will be utilized for operating the company's extensive mines. The General Electric Company will furnish two 150-kw generators. The water-wheels, two units of 250 hp each, will be supplied through the New York office of the Pelton Water-Wheel Company, 143 Liberty Street. Shipment by steamer to Batoum will be made in about 15 days. The plant will, it is anticipated, be considerably increased in the near future.

MAXWELL M. MAYER ELECTRIC COMPANY is a new incorporation under the laws of New Jersey, with a capital stock of $100,000; the business taken over being that started by Mr. M. M. Mayer under his own name some eight years ago, and made into a company about four years ago. It now contemplates doing business on a larger scale by increasing its productive and selling capacity. The officers are: Maxwell M. Mayer, president; F. Dehrenberger, secretary, and Frank Skidmore, treasurer. The concern has its dynamos and motors in use all over the world.

THE INDIA RUBBER AND GUTTA PERCHA INSULATING COMPANY, of Yonkers, N. Y., is installing alternating-current motors to replace a number of small isolated steam engines formerly used for driving the carpenter shops and the winding and braiding departments. A recent purchase from the Westinghouse Electric and Manufacturing Company includes motors of the following sizes: 1-hp, 5-hp, 10-hp and 15-hp. The manager of the company states that the motors are very satisfactory in the work, and that he is very much pleased with them.

ELECTRICAL PLANT FOR MEXICO.—The Descubridora Mining and Smelting Company, of Descubridora, Mexico, is about to add to its electrical plant, which was recently designed with a view to considerable extensions by Albert A. Cary, 95 Liberty Street. David Gough, the company's general manager, is now in the United States for the purpose of placing contracts. He is a guest at the Holland House. Thomas H. Watkins is president of the company. The New York offices are at 68 William Street.

THE STANLEY RULE AND LEVEL COMPANY, of New Britain, Conn., is about to adopt electric driving throughout its works. It has recently purchased from the Westinghouse Electric and Manufacturing Company a 375-kw, 500-volt, direct-current, engine-type generator, to be operated in connection with a marine-type engine, running at 200 r. p. m., furnished by Westinghouse, Church Kerr & Co.

TO BUILD TRANSMISSION LINE.—The Kern River Company, which recently let contracts for electric generators and water-wheels for a 10,000-kw transmission plant, to be located 12 miles below Kernville, Calif., will soon let contracts for the building of the transmission line. The distance from the station to Los Angeles will be from 110 to 125 miles.

LIGHTING GOULD'S PRIVATE CAR.—Mr. George Gould's private car "Atlanta," now being completed at the car works at St. Charles, Mo., and which, it is stated, will be a veritable rolling palace, costing $150,000, is being equipped with the Consolidated "Axle Light" system of electric lights and fans.

BRAZILIAN LIGHTING AND TRACTION SCHEME.—It is proposed to light the City of Maranhao, Brazil, electrically, and to construct an electric traction system there. Two engineers, James Robert Hislop and Edmund Clayton Barker, are interested in the project.

THE PENNSYLVANIA SALT MANUFACTURING CO., of Wyandotte, Mich., has recently purchased a number of direct-current motors from the Westinghouse Electric and Manufacturing Company, for installation in its plant at Wyandotte.

BIDS WANTED.—The Department of the Interior, Washington, is inviting bids until October 1, on the erection of an electric light and power plant, etc., for the Government Hospital for the Insane, Washington, D. C.

THE MANSFIELD ENGINEERING COMPANY, Mansfield, Ohio, has prepared plans for the installation of a power plant at the Sawyer Sanitarium, at Marion, Ohio. Considerable new machinery will be purchased.

General News.

THE TELEPHONE.

NEW DECATUR, ALA.—The Southern Construction & Telephone Company of Toledo, Ohio, has applied for a telephone franchise in this place.

SAN FRANCISCO, CALIF.—The Pacific States Telephone & Telegraph Company has filed an answer through its attorneys in the suit brought by the City of San Francisco to compel the payment of $280,000 delinquent taxes accruing from Oct. 8, 1898. These are license taxes imposed by the Board of Supervisors at the rate of $2 per year on each of the company's nickel-in-the slot signal boxes. It is denied that these boxes are slot machines, within the meaning of the ordinance which require a tax of $2 on all apparatus having the coin attachment. It is claimed by the company that the license tax is a double taxation as there is paid in annually at least $36,753 on the assessment of its properties. The tax ordinance was passed some years ago, but no attempt was made to enforce it with reference to telephone boxes until 1898, when an ordinance was passed directing the Tax Collector to begin legal proceedings against the telephone company for the delinquent boxes.

COLORADO SPRINGS, COLO.—The El Paso County Telephone Company has been incorporated with a capital stock of $200,000 by R. J. Belles, H. P. Lillibridge, J. F. Sanger and others.

MODE, ILL.—The Holland Township Telephone Company, capital $1,500, has been incorporated by W. B. Lantz, J. E. Gallagher and S. A. Egan.

ALTON, ILL.—The Kinloch Telephone Company has begun work stringing cables in every street in this city and upper Alton. An additional cable was found necessary to accommodate increasing business.

JERSEYVILLE, ILL.—The Jerseyville Telephone Company has extended its suburban service by running direct wires into Otterville, McClusky, Dow, Newburn, Fidelity, Medora and Kane. No toll is charged subscribers for this extra service.

ALTON, ILL.—The Calhoun Telephone Company, incorporated to construct a telephone line from Grafton, in Jersey County, through Calhoun County to Pike County, has started construction work. The new line will connect at Grafton with the long distance system, and an exchange will be established at Grafton.

UPLAND, IND.—There is talk of building a telephone line from this place to Jadden and Dundel.

MICHIGAN CITY, IND.—A short time before Lewis Russell was to be taken to the scaffold and executed for murder, Warden Reid, of the Northern Indiana Prison, received a telephone message from Governor Durbin respiting the doomed man for thirty days. This is the first instance of use of the telephone by an executive for such a purpose in this State.

INDIANAPOLIS, IND.—In the suit of the Western Electric Company against the United Telephone Company, of Marion, and Hugh Dougherty, as president, in the United States Court, asking that the Marion Company be restrained from the use of a certain multiple switchboard in its telephone exchange, the defendent has filed an answer which denies this exclusive right of the plaintiff company to this form of board.

INDIANAPOLIS, IND.—The Western Union Telegraph Company has asked the United States Court to perpetually enjoin the tax board from certifying the valuation made of its property this year. The board fixed the valuation of its property in this State at $2,242,722, while the company insists that it should not have exceeded $1,164,622. The board reduced the valuation from $63 to $57 a mile on account of the alleged reduction of local service by reason of the popular use of telephones, but this reduction was insufficient to satisfy the company, hence the suit.

EVANSVILLE, IND.—Mayor Covert and the city attorney still insist that the municipal telephone system will be a reality, and that the municipal telephone question is further from being a dead issue now than ever before. They say officers of banks and other capitalists have subscribed liberally for stock, showing the faith they have in the plan. Mayor Covert claims that when the council revoked the franchise of the Cumberland Company and ordered it to quit business within ninety days, it opened up the way for the municipal plant, and that capitalists no longer hesitate to put their money in the scheme. The mayor says that within the next few days there will be material developments in the municipal telephone question and that he is confident the success of the plan is assured.

INDIANAPOLIS IND.—During the closing session of the State Tax Board, the valuations of telephone companies were reduced in many instances. It was found, by arguments made by the appellant companies, that many of them were not doing well, and a few actually operating at a loss. Many of the larger companies have not paid dividends for years, and while future prospects are good, they are not in a condition at the present time to stand increased taxation. Telephone men before the board testified that the low rates with which the public is furnished telephone service make it impossible for the companies at the present time to reap substantial profits from the business. It was brought out that a great many companies, in order to obtain franchises, had agreed to furnish telephone rates that are too low. The total assessment on telephones will be $600,000 higher this year than last.

JEFFERSON, IA.—A mutual telephone company was organized here recently for the farmers in the vicinity and toward Jackson.

HINDMAN, KY.—The business men of this place are talking of building a telephone line to Hazard, Perry County.

BOWLING GREEN, KY.—The city has sold at public auction the franchise for an independent telephone exchange. The right was purchased by J. E. Mott. Wires are to be placed underground.

BALTIMORE, MD.—The Maryland Telephone Company, an independent line, is completing many extensions. The most important is a long distance line to Wilmington, Del., and Philadelphia. The line between Baltimore and Philadelphia will be opened in about two weeks. In ten days still another important long distance connection will be opened. This is the line to York, Pa. It will connect with the Baltimore company 10,000 telephones in the southern part of Pennsylvania, western part of Maryland, and in several towns in Virginia and West Virginia.

JACKSON, MISS.—The railroad commission has increased the valuation of the Cumberland Telephone Company's lines in Jackson and four other leading towns from $75 to $200 and from $10 to $40 for side lines.

ST. CHARLES, MO.—A telephone cable has been laid across the river, connecting the power house of the St. Louis, St. Charles and Western Railway at the foot of Adams Street, in this city, with the stations on the line in St. Louis County.

ST. LOUIS, MO.—The assessed valuation of some corporations has been materially decreased by the State board of equalization. This has partially made up by an increase in the valuation of others. The assessed valuation for 1902 of the property in St. Louis of each corporation is as follows: Western Union Telegraph Company, $83,926.99; Missouri District Telegraph Company, $15,175.48; Pacific Mutual, $6,353.91; American Telephone and Telegraph Company, $2,353.91; Bell Telephone Company, $823,134.72; Kinloch Telephone Company, $750,000.

JEFFERSON CITY, MO.—The State board of equalization has completed its work of fixing the assessment on the telegraph, railroad and telephone properties in Missouri for taxes for 1902. The telephone companies were assessed this year for the first time, their assessments being as follows: Bell lines, $900,000; Kinloch, $750,000; Missouri & Kansas, in Kansas City, $450,000. The local assessors also assessed these properties and the State board allowed their assessments to stand except in the cases of the big companies in the cities The principal increases are as follows: Western Union Telegraph Company, $200,000; Postal Telegraph Company, $60,000.

LE ROY, N. Y.—The Bell Telephone Company has been granted a franchise to do business in this place.

TUXEDO PARK, N. Y.—The telephone exchange at Tuxedo Park was destroyed by fire on the night of Aug. 29.

JAMESTOWN, N. Y.—At a recent meeting of the Home Telephone Company, of Jamestown, arrangements were made to secure long distance service with the Inter-Ocean Long Distance Telephone Company.

EASTON, N. Y.—A telephone company has been organized here with F. O. Ives, president; E. H. Borden, secretary; and E. J. Skiff, treasurer.

WILLISTON, N. D.—The Williston Telephone Exchange has been incorporated with a capital stock of $25,000 for the purpose of establishing and maintaining a telephone system at Williston and to extend it in time through Minnesota, Wisconsin, Montana and North Dakota. Incorporators: D. F. Collins, S. Dow and Geo. Dow, Jr., of Madison, Wis.

MIDDLETOWN, OHIO.—Representatives of the Dayton Home Telephone Company have asked for a franchise to install their system here.

MARION, OHIO.—The Central Union Telephone Company is making numerous improvements to its system at this point as well as at LaRue.

SALEM, OHIO.—The North Georgetown Telephone Company has extended its lines to Westville and will probably further extend them to Beloit.

KENTON, OHIO.—The Grocers' Association has decided to use only one telephone system, but which one is a question not yet settled. It will be decided by vote.

DELAWARE, OHIO.—The Stromberg-Carlson Telephone Manufacturing Company of Chicago has the contract for installing a new switchboard for the Delaware Citizens' Telephone Company.

SALEM, OHIO.—Exchange operators employed at the Salem exchange of the Columbiana County Telephone Company went on strike recently. They ask for a 33 per cent. increase in wages.

PAULDING, OHIO.—The Paulding Home Telephone Company is making numerous improvements at Payne and vicinity. Several small towns in the vicinity of Payne are being connected up.

TOLEDO, OHIO.—Manager Hamlin, of the Toledo Home Telephone Company, announces that his company has 3,000 telephones in operation. The company began charging for service on Sept. 1.

YOUNGSTOWN, OHIO.—Mr. W. W. Johnson, formerly manager for the Central Union Telephone Company at Youngstown, has accepted the position of superintedent of the American Telephone & Telegraph Company at Atlanta, Ga.

SPRINGFIELD, OHIO.—The Springfield & Xenia Telephone Company will commence work at once on the erection of poles. The company will build a fine block for an exchange building. An effort will be made to have the exchange in operation this winter.

TOLEDO, OHIO.—The Northern Ohio Construction Company has been incorporated with $10,000 by R. C. Packard, Alfred W. Allen, C. B. Lloyd, Wm. H. Golden and I. H. Packard. It will construct telephone and telegraph lines. The company will construct a telephone exchange at Ottawa, Ill., where a franchise has been secured.

CLEVELAND, OHIO.—The Cleveland Telephone Company (Bell) has adopted a new plan of advertising its service. For $1 it offers to install for a period of six months an unlimited residence telephone equipped for outgoing service only. It is expected that by the end of six months the user will become so attached to the telephone that he will subscribe for some other class of service. If he does not, the telephone will be taken out at the end of six months. A large number of new subscribers have been obtained for the service, and it is estimated that at least one half will become permanent subscribers.

CLEVELAND, OHIO.—The Everett-Moore syndicate announces that the Federal Telephone Company is to be dissolved, and that the remaining constituent companies are to be sold. The syndicate will retain its interests in the United States Telephone Company (the long distance company) and in the Cuyahoga Telephone Company (the Cleveland Company), but these will be handled as separate enterprises. Eleven of the subsidiary companies have been sold, leaving twelve for sale. H. A. Everett is quoted as saying that the syndicate in these sales is not clearing anything above its equity, hence there is little possibility that when the final clearing up takes place, there will be much left for the stockholders of the Federal Telephone Company.

YORK, PA.—By the consummation of a deal of the independent telephone companies of Maryland and Pennsylvania, York will soon have direct communication with Baltimore, Philadelphia, Wilmington, Charleston and other cities in Maryland, Pennsylvania, Delaware, Virginia and West Virginia. The lines of the combined company will meet at the Maryland and Pennsylvania border. It is expected that the Maryland and other extensions will be completed within a fortnight.

DENTON, TEX.—The Southwestern Telegraph and Telephone Company has been granted a franchise at this place.

CLEBURNE, TEX.—The City Council has granted a franchise to Messrs. F. B. McElroy, of Ft. Worth, and J. H. Keith, of this city, for the construction of a new telephone system here.

RICHMOND, VA.—The new Bell telephone system has been completed. Over 3,400 lines are now installed and the switchboard will accommodate 3,800 additional lines, giving a capacity of over 28,000 telephones.

LA CROSSE, WIS.—The operators of the La Crosse Independent Telephone Company struck recently because Miss Jennie Irwin, the chief-operator, it is alleged, was "stuck-up." The girls have no other grievance, but at last accounts a settlement of the trouble was not in sight. The service is crippled and 150 business men have petitioned the company to listen to the girls' demand. The petition has, however, been ignored.

ELECTRIC LIGHT AND POWER.

JUNEAU, ALASKA.—The Juneau Power Company has been incorporated for the purpose of installing a 10,000-hp electric power plant to supply Juneau and vicinity.

BISBEE, ARIZ.—The Douglas Improvement Company, Bisbee, will construct an electric lighting plant and an ice plant.

CORONA, CALIF., is to have a municipal electric lighting plant. The City Trustees have authorized F. A. Worthley to draw up specifications for the initial installation of at least 100-hp.

YREKA, CALIF.—A. H. Barr has filed water rights on 3,000 inches of water of Aetna Creek near Yreka for the purpose of developing power in connection with an electric plant.

LOS ANGELES, CALIF.—The Pacific Light & Power Company of Los Angeles is the merger company into whose system the Kern River plant will feed. It is owned by the Huntington-Hellman syndicate.

SAN FRANCISCO, CALIF.—The Northern California Power Company has completed a new substation in Redding, Calif. A ten-mile transmission line is being constructed to Horsetown, on Upper Clear Creek, where power will be furnished for gold dredging. A branch line will supply power for motor pumping for irrigating land. The new extension to Willows has just been completed. Other extensions will be made and the transmission line from Red Bluff to Corning will be rebuilt this year. It is expected that the company will furnish electric power to operate a projected electric railway from Willows to the Sacramento river.

SAN FRANCISCO, CALIF.—It is reported that the Bay Counties Power Company has made an offer to build a power house and substation for the Oakland Transit Consolidated, in Oakland, Calif. When the Transit Company placed its large bond issue, provision was made for the sum of $300,000 for the construction of an electric power house at Emeryville. This is to be built whenever the directors consider it necessary. At present a large amount of current for the operation of the Transit Company's street railway system is purchased from the Bay Counties Power Company. The supposition is that by providing for the installing of a reserve power plant the Transit Company would insure the securing of low rates for electric power from the companies having transmission lines. By offering to build a plant in Oakland the Bay Counties Power Company would make sure of retaining the business of the street railways.

LOS ANGELES, CALIF.—The Edison Electric Company of Wyoming, which was incorporated recently, proves to be the Los Angeles Edison Company, a copy of the articles having been forwarded to Los Angeles for filing with the County Clerk. The capital stock is $6,000,000. The trustees are Henry Fisher, John B. Miller, H. H. Sinclair, F. H. Rindge, John S. Cravens, James C. Drake, William R. Staats, J. S. Torrence and Walter S. Wright. It amounts to a formal consolidation of the Edison Electric Company, of Los Angeles, the Redlands Electric Light and Power Company, the Southern California Power Company and the California Power Company. The Redlands Company is completing a large electric transmission plant known as Mill Creek No. 3. The Southern California Power Company built the 80-mile electric transmission line from the Santa Ana river to Los Angeles. The California Power Company has made preparations to install a 15,000-kw plant, which will be located on the Kern River and will transmit current 116 miles to Los Angeles. Additional plants will be installed as the business grows and other cities will be supplied with electric power.

WASHINGTON, D. C.—The Potomac Electric Power Company and the United States Electric Light Company Company of this city have been merged under the name of the former company, and the capital stock of the Potomac Electric Power Company increased from $1,000,000 to $3,000,000. By the deed of reorganization the Potomac Company purchased the United States Company, paying $3,250,000 in stock of the Potomac Company. All the floating debt and contracts of the United States Company will be assumed by the Potomac Company and to this end $6,500,000 mortgage bonds will be issued.

BELLEVILLE, ILL.—The Belleville Gas Light and Coke Company has increased its capital stock from $150,000 to $300,000.

PANA, ILL.—The city has awarded a contract for the erection of a municipal electric light plant to T. C. Reid, of St. Louis. Mr. Reid proposes to erect a plant with a capacity of 82 arc lamps of 2,000 candle power each for $16,000, the Council to pay for it in installments. Before the work is begun a majority of the property-holders must sign a petition for it, after which the erection of the plant will be begun at once. For the last month the city has been in darkness, the Council being unable to reach an agreement with the Pana Modern Electric Light Company. The city will accept the last proposition of $5 a month per light until the municipal plant has been completed.

SIOUX CITY, IA.—The Sioux City Gas & Electric Company is spending $25,000 in rewiring the entire city and equipping the electric light system with new poles.

PLAQUEMINE, LA.—The town of Plaquemine has granted a franchise to Dr. W. A. Holloway and associates for an electric and power plant.

ST. LOUIS, MO.—A bill authorizing the creation of a sinking fund with which to install and operate a municipal lighting plant has been prepared by the president of the Board of Public Improvements. A certain per cent. of municipal revenues, the bill provides, shall be set aside each year for six years for the construction of the plant.

HUNTINGTON, N. Y.—The Town of Huntington Light and Power Company of Huntington, Suffolk County, has been formed; capital, $75,000. Directors: W. N. Baylis, H. S. Brush, and Douglas Conklin, of this place.

GENEVA, OHIO.—C. W. Goodrich, of this place, has bought the material and equipment of the old electric lighting plant.

GALION, OHIO.—The Galion Gas Light Company has submitted a proposition for the purchase of the municipal lighting plant. The company proposes to improve the plant.

EUGENE, ORE.—An offer has been made for the purchase of the electric lighting plant in Eugene by representatives of Eastern capitalists. It is represented that a system of electric railways will be built through the Willamette Valley, which will be operated from water power electric plants to be established at various points. It is also claimed that a number of electric power plants will be constructed and operated through the territory extending from San Francisco to Portland, Ore. It is not known who are the backers of the proposed enterprise.

WINNSBORO, S. C.—The city lighting bonds have been sold to a Northern firm and W. B. Smith-Whaley, of Columbia, S. C., has been selected to engineer the installing of the electric plant.

OTTAWA, ONT.—The new stone power house of the Consumers Electric Company, of Ottawa, which is affiliated with the Hull & Ottawa Power Company, has just completed, and the machinery has all been installed with the exception of the switchboard. The temporary frame structure will be abandoned shortly. About 10,000 horse power has been developed for heat, light and power, which can be furnished in large quantities. Over $500,000 has been expended on this work. An idea of its magnitude may be gained when it is said that over 125,000 cubic feet of solid rock has been excavated. The company is now in a position to furnish about 12,500 horse power of electrical energy.

THE ELECTRIC RAILWAY.

SAN FRANCISCO, CALIF.—Solicitors are at work in Nevada County, Calif., seeking to secure rights of way for the construction of an electric railway from Marysville to Newcastle, Auburn and other points.

SAN FRANCISCO, CALIF.—The United Gas & Electric Company, which distributes the current of the Standard Electric Company in the counties south of San Francisco, has been negotiating for some time with the owners of the San Jose & Santa Clara Railroad Company for the purchase of the electric railway lines. This deal, which is likely to be consummated, would give the Gas & Electric Company control of all the lighting and power enterprises in San Jose. The Standard Electric current was recently turned into the lighting circuits of the city for the first time and the local electric lighting plant was shut down. A large steam-power reserve station is kept ready for emergencies.

HONOLULU, HAWAII.—The Honolulu Rapid Transit Company, Honolulu, has been granted a franchise by the Superintendent of Public Works for the construction and operation of an electric railway line on the Waikiki road.

NEWCASTLE, IND.—Chas. Hernley has been granted a street railway franchise in this city.

ELKHART, IND.—The Elkhart, South Bend & Chicago Railway Company, which proposes to connect Elkhart, South Bend and Mishawaka, has filed articles of incorporation. The capital stock is placed at $15,000.

INDIANAPOLIS, IND.—The Fort Wayne, Logansport & Lafayette Traction Company, with a capital stock of $1,000,000, has been incorporated by the Union Traction Company syndicate to construct a line from Fort Wayne to Lafayette by the way of Logansport.

SOUTH BEND, IND.—The South Bend Northern Railway has been incorporated with a capital stock of $10,000. Clyde Smith and E. T. Gaffney are members of the board of directors. The road will constitute a connecting link between the South Bend local system and the South Bend & Southern Michigan electric railway.

MADISONVILLE, KY.—An electric railway is projected to run from Morganfield to Sebree.

LEXINGTON KY.—Harold C. Beatty, secretary of the Bluegrass Consolidated Traction Company, announces that arrangements have been completed for the building of six interurban roads. Work has been started on the line to Versailles.

JACKSON, MISS.—The citizens of Jackson are demanding and working for separate street cars for whites and blacks, and if the matter is not adjusted locally, it will be carried before the State Legislature.

DURHAM, N. C.—Mr. Wright has proposed to subscribe $50,000 for a twelve-mile electric railway to Chapel Hill, if the citizens will invest a similar amount.

LANCASTER, OHIO.—The Lancaster Traction Company is planning a number of improvements. New rails will be laid and a portion of the line will be double tracked.

SPRINGFIELD, OHIO.—Bids have been called for for the construction of a road over the route desired by the Springfield, Piqua & Sidney Traction Company for its entrance to Springfield.

CINCINNATI, OHIO.—The Tennis Electric Railway Company, of this city, has secured a contract for building the electric railway between Jefferson and New Albany, Ind., a distance of ten miles.

WARREN, OHIO.—Citizens of Mesopotamia, Bloomfield, Greene, Gustavus and Kinsman have subscribed $200,000 to the bond issue of the proposed Kelimworth-Warren branch of the Cleveland & Sharon Railway.

SANDUSKY, OHIO.—With the completion of the proposed Sandusky, Clyde, Tiffin & Southern Railway, and of the Urbana, Bellefontaine Northern, now building, there will be an unbroken line of electric railways from Sandusky to Cincinnati, a distance of 225 miles.

COLUMBUS OHIO.—Several municipalities will endeavor to induce the Legislature to repeal the Thompson Bill, passed last summer. The bill provides that railway crossings and bridges shall be lighted with arc lamps. It is claimed the law works a hardship on the lighting departments of many towns.

HAMILTON, OHIO.—The Miami & Erie Canal Transportation Company has brought up all the canal boats operating on the canal between Cincinnati and Dayton. Construction boats are now operating between Cincinnati and Hamilton, using direct-current motors and transmission, but as soon as the Dayton section is completed, alternating current equipment will be used throughout.

YOUNGSTOWN, OHIO.—Stockholders of the Mill Creek Valley Railway Company and the Hamilton, Glendale & Cincinnati Traction Company voted unanimously to consolidate the two lines into the Cincinnati & Hamilton Traction Company, preparatory to a lease to a new company of which President Schoepf, of the Cincinnati Traction Company, is at the head. The new company will have $2,200,000 capital stock divided equally into preferred and common. It is announced that the officers will be H. H. Hoffman, president; Bayard Kilgour, vice-president; Henry Burkhold, secretary-treasurer; A. C. Becht, assistant secretary-treasurer, and C. H. Kilgour, O. B. Brown and F. T. Homer the remaining directors.

AUSTIN, TEX.—The Union Traction Company, of Saginaw, Mich., is in correspondence with the municipal officers of Waco and Dallas, Tex., in regard to building an electric railway to connect those two cities. The distance is more than one hundred miles, but such a road would traverse a thickly populated section of the State and pass through a number of thriving towns.

NEW INDUSTRIAL COMPANIES.

THE DICKEY-SUTTON CARBON COMPANY has been formed at Lancaster, Ohio, and will soon be incorporated. It will build a factory for the manufacture of carbons.

THE ELECTRIC CONSTRUCTION AND MACHINERY COMPANY, Rock Island, Ill., has been incorporated; capital, $25,000. Incorporators: John T. Marron, William H. Dichman and Herman T. Schmidt.

THE NEW YORK ELECTRIC HEADLIGHT AND TRAIN LIGHTING COMPANY, of Yonkers, has been formed; capital $1,000. Directors: H. D. Crippen and W. J. Huston, of New York City, and F. A. Curtiss, of Nutley, N. J.

THE ELLIOTT BROTHERS ELECTRIC COMPANY has been incorporated at Cleveland, Ohio, with $25,000 capital, by J. E. Elliott, W. H. Elliott, E. E. Elliott, J. H. Colwell and K. L. Palmer. They have opened a factory on Hamilton Street and will do all kinds of electrical repairing, making a specialty of street railway work.

LEGAL.

LIQUIDATED DAMAGES.—The stipulated amount to be paid by an electric light company to a city, under a bond requiring it to complete the installation of its plant, for which the city has granted the use of its streets, within a specified time, is held in the case of Salem against Anson, to be properly regarded as liquidated damages, so that the whole amount must be paid in case of failure to meet the requirement, although the city proves no actual damage.

PERSONAL.

MR. H. A. ORR, superintendent of the Water, Light and Power Company, Anderson, S. C., has accepted the position of general Southern agent for the Stanley Electric Company.

MR. HAYDN T. HARRISON, an English electrical engineer who has been in this country for a short time studying electric light conditions, sailed for home at the end of last week.

MR. PAUL SCHUELER, of Magdeburg, Germany, an engineer in the railway service of the Imperial Government, is now visiting this country to study our steam and electrical methods of transportation.

MR. ANDREW PINKERTON, Electrical Engineer of the American Sheet Steel Company, Vandergrift, Pa., was married Aug. 30, at Apollo, Pa., to Miss Elizabeth McCauley, daughter of Dr. A. McCauley, of that city.

MR. J. STEWART THOMSON, who is well known in machinery and electrical circles in New York City from his connection with the New York Safety Steam Power Company, was married on Sept. 3, at Cleveland, Ohio, to Miss L. C. Thomson, of that city.

MR. L. A. FERGUSON.—In the note in last week's issue regarding Mr. Ferguson's attendance at the Edison Convention this week it was stated that he was chief engineer of the New York Edison Company. This was an obvious error, the word "New York" having become substituted for "Chicago." Mr. Ferguson has not left the Western metropolis, as might be inferred from the original item.

PROF. H. HABER, of the Karlsruhe Technician Hochschule has arrived in the United States, where he will make a study of the American electro-chemical industry, as a representative of the German Bunsen Society, to which he will render a report of the results of his visit. Dr. Haber is also accredited as an official delegate to the coming meeting of the American Electrochemical Society, at which he will read a paper.

MR. EUGENE LEWIS, the well-known leader of New York's "electrical bar," has just carried through at Greenwich, Conn., some very successful theatricals for the benefit of a local church fund. His wife, formerly Miss Amy Busby, of the American stage, participated, and Mr. Charles P. Geddes, as well as Miss Jessie Moore, daughter of Mr. Charles A. Moore, also were active and clever participants.

MR. A. H. KOEBIG, a civil engineer in the service of the Edison Electric Company of Los Angeles, Calif., who has been at work for that company in Fresno County, has just located there the biggest sequoia tree, which has a circumference of 109 feet, or a diameter of 32 feet. It is surrounded by other magnificent specimens. The Los Angeles Company is carrying out some extensive plans of power transmission.

MR. CHARLES E. HEWITT, who has been the senior partner in the firm of Hewitt & Warden, Newburgh, N. Y., has disposed of his interest in the above-named firm and is now the president of a new company, incorporated under the laws of New York, under the name of C. E. Hewitt & Co. The work of the new company will be mainly constructing central stations, and it will make a specialty of marine electrical construction.

MR. ALEX. C. HUMPHREYS.—The Trustees of Stevens Institute, Hoboken, have received a cable dispatch from Alexander C. Humphreys, now in Europe, accepting the position of president of the Institute, to succeed the late Henry Morton. Mr. Humphreys graduated from the Institute and is now senior member of the firm of Humphreys & Glasgow, gas engineers, of New York and London. He was elected president of the Institute in June last, but being then about to sail for Europe, declined to accept the position at once.

THE DUKE OF MARLBOROUGH, who has taken up automobiling, believes in keeping the machine under his own control, even though he is not driving himself. To accomplish this result the Duke has fitted his fifteen-horse power Mors with an ingenious arrangement, designed by himself, which takes the form of an indicator on the dashboard similar to the telegraph used on board ship. On the dial are directions to stop, go on, turn to the left or right, go slower or faster, turn right around, etc. By means of an electric button the Duke, serenely seated in the shelter of the limousine body, is able to direct the driver without exposing the occupants of the automobile to the weather.

MR. FRANK W. BEEVAN, chairman of the board of directors of the Anglo-American Telegraph Company, London, now on a trip through Canada and the United States, when asked his opinion of the Marconi researches from a practical standpoint, said: "While no doubt Marconi has made some wonderful discoveries, I do not think there is any reason at present to fear competition from his system. For instance, his system is not sufficiently perfected to be able to transmit accurately the intricate figures of brokers' quotations. So far as the Anglo-American Telegraph company is concerned, we recently sent upwards of 1,063 messages between London and New York in two hours, and so long as we are able to give such a rapid service at the present reasonable rates, I think the public requirements are being well met." In answer to a question whether there were any new cable schemes in view, Mr. Beevan replied that he knew of none excepting that the German Company intends laying another cable to America.

MR. M. R. HUTCHISON returned to New York Aug. 29 from a stay of several months in Europe which was passed in bringing to the attention of the public his instruments to assist the hearing of the deaf. While in England Queen Alexandra became very much interested in the system of Mr. Hutchison, though the statement that has appeared in the papers to the effect that he treated the Queen is incorrect, as it appears that Her Majesty is nowise in need of treatment for deafness. The first time Mr. Hutchison was summoned before the Queen there were present at a test, in addition to Her Majesty, Princess Victoria, the Duchess of Manchester and Leeds, several other members of the court, and a distinguished aurist before whom this instrument was first demonstrated in London. This seance lasted for an hour and a half, and some weeks later Mr. Hutchison was summoned aboard the royal yacht "Victoria and Albert," where he spent the day and before leaving Her Majesty handed him a handsome gold medal, saying: "Presented to Murray R. Hutchison by Alexandra, Queen, as a token of friendship and reward of merit for scientific invention and investigation." While in London Mr. Hutchison was requested by the Duke of Cambridge to call on him at the Gloucester House to show his system, and later was asked to dine there with the Duchess of Kent, the Lord Mayor of London, and many other titled personages. The Duke of Cambridge called on Mr. Hutchison several times at the Hotel Cecil and investigated the system very closely. At a seance given in honor of the Duke of Cambridge by Mr. Hutchison at Hotel Cecil, Mr. David Bispham, of the Metropolitan Opera Company, sang to the deaf mutes present. The company on this occasion included, besides a number of the nobility, a considerable party of Americans. While in Paris an exhibition was given before the Grand Duke and Duchess Vladimir and a party of other distinguished people. On Aug. 4 the instruments

were demonstrated before the British Medical Association, at Manchester, Eng. The Queen took a particular interest in Mr. Hutchison's invention, and during his stay in London he was summoned a number of times before Her Majesty at Buckingham palace, and from her received an invitation to attend the Coronation ceremony at Westminster Abbey, as well as being accorded permission to take a party of Americans through Westminster Abbey the Monday after the Saturday on which the King was crowned, and before the Abbey had been opened to the public.

Trade Notes.

THE BOSWORTH-HOLDING COMPANY, of Cleveland, dealers in new and second-hand electrical equipment, has opened a new establishment at 22 South Water Street, that city.

THE H. B. CAMP COMPANY, reports sales as exceedingly good at present for its underground conduit products. The company has largely increased its facilities to enable it to fill all contracts promptly.

THE BURT MFG. CO., of Akron, Ohio, reports that ten governments are now using its Cross oil filters. It has just made an important shipment of these filters and its Burt exhaust heads to Buenos Ayres for the Argentine government.

LANE & BODLEY COMPANY, engine builders, Cincinnati, Ohio., is planning a new foundry for its own Corliss engines and for jobbing foundry work, and invites the submission of new plans, ideas or apparatus, for inclusion in it. Blue prints can be had on application.

THE FROST CROSS ARM AND LUMBER COMPANY, of Cleveland, Ohio, has been incorporated under the laws of Delaware. Mr. A. S. French is at the head of the company, and has offices in the Century Building, Cleveland. The company will make cross arms for telephone and telegraph lines.

THE NATIONAL INCANDESCENT LAMP COMPANY, Cleveland, Ohio, which some time ago purchased the plant of the old Brush Electric Light Company, has moved its general offices from the Electric Building to the office building formerly occupied by the Brush Company at the corner of Mason and Belden Streets.

THE CLIFTON MANUFACTURING COMPANY has removed from 511 Washington Street to 308 West Street, New York, where much larger space is available for the carrying of a large stock of fire proof insulating conduit, electrical tapes and splicing compounds. The New York agents of the company are Messrs. F. H. Willmont and F. W. Smith, formerly with the Western Electric Company.

THE ELECTRIC APPLIANCE COMPANY, Chicago, selling agent for Packard incandescent lamps, lately asked its customers for their opinion regarding the lamp. The hundreds of testimonials that have resulted from this request have been numbered, and are being exhibited as a chain of evidence as to the excellence of Packard lamps. It makes an exhibit of which both the manufacturers and the selling agents have a right to be proud.

BRAZING CAST IRON has, it is said, at last been accomplished by a German who has secured patents in thirteen countries. Companies have been organized in each of the thirteen countries including the United States, and in this country the company has, it is alleged, been making so much money from the brazing plants it has in operation, that others are to be placed as speedily as possible in every large town in the country. The American Brazing Company of Philadelphia, 136 South Fourth Street, has secured the American rights. We know nothing personally of the merits of the process.

IDEAL STEAM ENGINES.—A very handsome pamphlet has just been issued by A. L. Ide & Sons, Springfield, Ill., giving a very complete description of their automatic cut-off steam engines. The construction of these engines is very fully gone over and illustrations show the constructional details in a very clear manner. Views are also given of the various styles of "Ideal" engines, many of which are directly connected to electric generators. This engine has become well-known and is widely used in the electrical industries on account of its close regulation and especial fitness for driving dynamos and generators.

WATERBURY BRASS COMPANY, 122 Centre Street, New York City, has now ready for mailing its new stock catalogue, classifying brass, copper, bronze and German silver in sheets, rods and wire, also brass and copper seamless drawn tubing which it is carrying in its New York warehouse. This catalogue also illustrates stair treads and mouldings, brass ferrules and checks. They have also compiled a complete table of weights and measures bearing on brass and copper sheets, rods, wire and tubing. This catalogue has been prepared at considerable expense and is one of the most complete catalogues that has been issued for the hardware trade, electrical manufacturers, and buyers in general of brass and copper. It can be had for the asking and this enormous stock is ready for shipment on receipt of order.

AN EMPLOYMENT BUREAU.—The Chicago & Alton Railway has established an employment bureau, the purpose of which is to recruit employes from among the people living along the line of the Alton road. The head of the "Alton" employment bureau meets citizens living in towns upon and adjacent to the line of the Alton railway for the purpose of getting in touch with young men of good habits and high character who would like to become employes. Students in telegraph offices, clerks in various departments, operators, brakemen, firemen, etc., are recruited from persons whose record is kept by the bureau; the selections being made from those who are best suited and qualified after having passed mental and physical examinations which have been made a part of the requirements for employment by the company.

CEMENT BUTTS.—The "Durable Cement Butts," manufactured by the Durable Cement Post Company, Battle Creek, Mich., embodies a novel idea in the manufacture of poles for telephone, telegraph and electric railway trolley lines. The use of these cement butts permits of the use of short poles, which are often considered worthless for that reason, and poles which have become rotted at the butt may be saved and the part above ground utilized by placing them on cement butts. The butts are octagonal in form, of various lengths, and are placed in the ground in the usual manner, the top of the butt projecting above the surface a few inches. The bottom of the pole is set on the top and fastened thereto by stout iron straps, which are firmly bolted to the pole and the butt. These butts possess many advantages, which are well described and illustrated in a pamphlet issued by the company.

ELECTRIC AND COMBINATION FIXTURES.—A catalogue of electric and combination fixtures of extreme excellence and splendid detail has been issued by the Dale Company, 20 Thames Street, New York, as No. 11 of its series. Practically everything in the nature of an electrical fixture is shown in this catalogue, which covers 136 pages; is printed on good paper; contains well-made intelligible illustrations and is strongly and handsomely bound. The book illustrates portable fixtures of all sorts, some of which are very handsome designs; brackets, bracket tubes, canopies, ceiling fixtures and pendents, electroliers and column lights and some very ornamental designs for newell posts. In addition a line of canopies, receptacles, shade holders and shades are shown, giving a fitting finish to the catalogue which is a very complete publication and should be in the hands of every electrical man interested in fixture work.

"GOOD STOCK NEEDS GOOD LIGHTING," is a truth realized this season as never before by the leading merchants throughout the country, as evidenced by their orders for reflectors to the well-known house of I. P. Frink, 551 Pearl Street, New York. Among the many contracts for Frink's special patent window reflector and show case lighting in hand or recently filled we are advised of the following: Gimbel Bros., Philadelphia; also their Milwaukee store; Bloomingdale Bros., N. Y. City; Siegel-Cooper Co., N. Y. City; the handsome new buildings of Saks & Co., and R. H. Macy & Co., N. Y. City, two stores which because of their location have attracted general attention; Derby Desk Co., Boston; Washington Arcade, Detroit; Kennedy Furniture Co., Butte; L. Hammill & Co., Mobile, Ala.. who are conceded to have one of the finest store buildings in the South; J. N. Mockett, Toledo, Ohio; Hannifin Dry Goods Co., Milwaukee; and "The Leader," Minneapolis, Minn. It might be mentioned that in addition to their special line of reflectors for window and case lighting this concern manufactures a full line of cluster reflectors, mirror shades, etc. The former are well adapted to the lighting of store interiors being preferred by many to the enclosed arc. The Wadleigh High School, N. Y. City, about completed, has some 800 "Frink" clusters which are the standard type of the N. Y. Board of Education. The additional fixtures in this building, consisting of ceiling coronas with bent glass domes, and arch reflectors, were all furnished by this firm. Their catalogue fully illustrates and describes their fixtures and is intended to reach every central station, electrical engineer, contractor and supply dealer. A copy will be sent on request.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED SEPT. 2, 1902.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

708,006. ELECTRIC SWITCH; H. P. Ball, New York, N. Y. App. filed March 21, 1901. Solenoids mounted in line with each other carry the circuit closing bar on their joined cores. The solenoids are ironclad, the magnetic circuit being formed partially by the bracket in which they are mounted.

708,007. TIME LIMIT DEVICE FOR CIRCUIT BREAKERS; H. P. Ball, New York, N. Y. App. filed Jan. 29, 1902. Means provide for adjusting the time-limit between the energizing of the overload device and the circuit breaker, whereby several time limit devices can be incorporated in a distribution system and adjusted to operate independent circuit breakers at different times.

708,008. REVERSE CURRENT DEVICE FOR CIRCUIT BREAKERS; H. P. Ball, New York, N. Y. App. filed Jan. 29, 1902. A device adapted for use in connection with any type of circuit breaker to open the same should the direction of current be reversed.

708,016. REGULATING SOCKET; L. F. Bogia, Philadelphia, Pa. App. filed Sept. 20, 1901. A key-socket containing a variable resistance adapted to be inserted at the point where a branch circuit leads off from the main.

708,024. COUPLING FOR ELECTRIC MOTORS; F. E. Case, Schenectady, N. Y. App. filed Feb. 15, 1901. A coupling for use in conductors between cars of a train; one section carries a pair of brushes which bears against a plug held in the other section.

708,025. ROTARY TRANSFORMER; Alexander Churchward, Chicago, Ill. App. filed June 12, 1899. The converter armature is provided with two circuit windings in the case of a two-phase machine, or three separate windings in the case of a three-phase machine, each of which has its own commutator.

708,026. ELECTRIC CONTROLLER; W. H. Clarke, New York, N. Y. App. filed Oct. 11, 1901. An electro-magnet in the shunt circuit of the dynamo controls a steam valve which co-operates with a differential piston to control the supply of steam admitted to the engine which drives the dynamo.

708,032. ELECTRIC ARC LAMP; E. A. Edwards, Cincinnati, O. App. filed Nov. 25, 1901. Improvements in the details of construction for the purpose of securing a regular and uniform feed of the carbon.

708,036. MOUNTING FOR ELECTRIC HEATERS; E. E. Gold, New York, N. Y. App. filed Oct. 16, 1901. The heater is adapted to be placed under twin movable car seats and partakes of a motion in conformity with that of the seat.

708,048. TROLLEY HARP OR FORK; O. P. Johnson and F. P. Crockett, Kalamazoo, Mich. App. filed April 28, 1900. Improvements in the strap spring which conveys the current from the wheel to the harp.

708,055. ELECTRIC CONTROLLER; J. B. Linn, Schenectady, N. Y. App. filed Feb. 15, 1901. The members of the cut-out switch are so constructed and arranged that whenever either of the motors of a two-motor equipment are cut out of circuit, the controller cylinder is automatically prevented from passing to the parallel position.

708,070. COHERER; G. W. Pickard, Boston, Mass. App. filed Oct. 18, 1901. The plugs of the coherer have concave inner faces, thus furnishing a uniform V-shaped space for the particles, regardless of the side upon which the coherer rests.

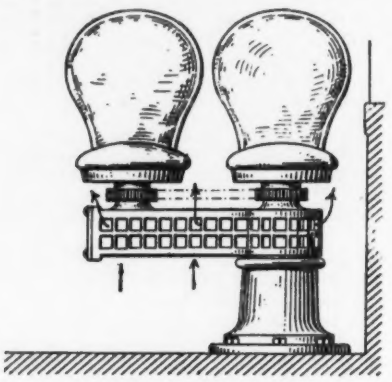
708,071. WIRELESS TELEGRAPH SYSTEM; G. W. Pickard, Boston, Mass. App. filed Oct. 29, 1901. The provision in the receiving apparatus of a decohering device which has its power of tapping regulated according to the low or high resistance of the coherer.

708,072. WIRELESS TELEGRAPHY; G. W. Pickard, Boston, Mass. App. filed Nov. 4, 1901. A terminal station in which is provided a means for automatically disconnecting and connecting a wave-responsive device in operative position as the air wire is disconnected from or connected to the receiver of the terminal station.

708,093. ELECTRICALLY PROTECTED STRUCTURE; H. M. Sutton, W. L. Steele, and M. Coerver, Dallas, Texas. App. filed May 25, 1901. Conductors arranged in crossing and recrossing grooves in the wall of a structure.

708,096. CONTROLLER FOR ELECTRIC MOTORS; L. A. Tirrill, Lynn, Mass. App. filed Feb. 14, 1901. The controller provides for cutting off the power and short circuiting the armature to cause the motor to operate as a braking generator, in case of an overload or the opening of a hand switch by an attendant, the result in either case being to open the circuit of an electro-magnetic unlocking device and permit a spring to throw the controller cylinder back to braking position.

708,105. CASE FOR FAN MOTORS; H. R. Wellman, New York, N. Y. App. filed Nov. 16, 1901. The case is formed of two parts which when united serve to support the armature of the motor, one part which is removable, also supporting the brushes.



708,036.—Mounting for Electric Heaters.

708,112. ELECTRIC CLOCK; H. E. Andersson, Stockholm, Sweden. App. filed Dec. 1, 1900. Details.

708,121. DEVICE FOR OVERCOMING ALTERNATING CURRENTS IN DIRECT CURRENT CIRCUITS; H. Brockelt, Berlin, Germany. App. filed March 28, 1902. (See Current News and Notes.)

708,132. ELECTRIC ARC LAMP; R. Fleming, Swampscott, Mass. App. filed Dec. 6, 1900. The reactance coil is inclosed in a magnetic cage with a central core provided with an air gap to avoid placing the coil at a distance from the lamp mechanism.

708,155. ELECTRIC ATTACHMENT; J. C. Meloon, Providence, R. I. App. filed March 1, 1898. The actuating device of a switch lever is connected with a diaphragm which is moved by fluid pressure.

708,157. CONTROLLER FOR ELECTRIC MOTORS; F. A. Merrick and E. W. Stull, Johnstown, Pa. App. filed Jan. 2, 1902. By means of compound locking devices the series-parallel switch normally held at its series position, cannot be operated to connect the motors in multiple until the latter has been brought to a sufficient degree of speed by the operation of the rheostat switch.

708,158. CONTROLLER FOR ELECTRIC MOTORS; F. A. Merrick and E. W. Stull, Johnstown, Pa. App. filed Jan. 2, 1902. Electro-magnetic means of improved character for "blowing out" arcs at the controller contacts.

708,159. INCANDESCENT LAMP; H. E. Meyers, Butte, Mont. App. filed Aug. 19, 1901. Filaments of different candle power are switched into and out of circuit by twisting the lamp in the socket.

708,182. CIRCUIT INTERRUPTER; Milo S. Walker, Chicago, Ill. App. filed Nov. 6, 1899. Relates to means for regulating the action of a circuit interrupter of the Caldwell type.

708,185. MAGNETIC SEPARATOR; J. P. Wetherill, South Bethlehem, Pa. App. filed Aug. 26, 1901. The main feature of the invention consists in supplying the material to be separated to interpolar spaces formed between opposing magnet poles immersed in a suitable water tank, whereupon the heads are detained in said spaces until the accompanying tailings have been washed away.

708,186. MAGNETIC SEPARATOR; J. W. Wetherill, South Bethlehem, Pa. App. filed Aug. 26, 1901. Modification of 708,185.

708,187. MAGNETIC SEPARATOR; J. P. Wetherill, South Bethlehem, Pa. App. filed Aug. 26, 1901. A further modification of 708,185.

708,188. LIGHTNING ROD; J. O. Wilson, Canton, Mo. App. filed Jan. 6, 1902. The ground plates are electro-opposite and maintain a current through the lightning rod, to render it more sensitive to electrically charged clouds.

708,195. CONTROLLING DEVICE FOR ELECTRIC GENERATING SYSTEMS; J. H. Backford, Salem, Mass. App. filed Dec. 18, 1900. The invention consists of a starting device adapted to be manipulated by the operator to perform a number of successive acts, whereby the system is started.

708,198. TROLLEY; J. W. Brooks, Indianapolis, Ind. App. filed Jan. 16, 1901. An anti-friction knuckled joint is formed in the harp to permit the wheel to readily follow the wire.

708,070.—Coherer.

708,211. ELECTRIC SNAP SWITCH; L. W. Downes, Providence, R. I. App. filed May 3, 1902. Details.

708,216. ELECTROMEDICAL APPLIANCE; J. O. Fowler, Jr., New York, N. Y. App. filed March 30, 1901. A battery cell is located inside of a massage roller and an induction coil in the handle is connected in circuit with a circuit breaker and with the cell and the surface of the roller.

708,220. MEANS FOR WINDING CONVERTERS OR LIKE ARTICLES; E. R. Gill, New York, N. Y. App. filed March 30, 1899. Two half portions of a spool are secured together around the core by fastening devices and the heads of the spool are grooved to receive a belt for rotating it.

708,253. ELECTRIC CLOCK; A. F. Poole, Wheeling, W. Va. App. filed Sept. 7, 1901. Improvements in details of a master and secondary clock system.

708,309. MANUFACTURE OF GLASS BY MEANS OF ELECTRICITY; J. Bronn, Cologne, Germany. App. filed Sept. 21, 1901. (See Current News and Notes.)

708,329. LIGHTNING ARRESTER; C. E. Egan, Durham, N. C. App. filed March 11, 1901. Details.

708,334. ELECTRIC ACCUMULATOR PLATE; A. Fischer, Berlin, Germany. App. filed June 21, 1902. A serpentine-folded plate having tongues cut in the apex of each fold and bent outward to receive the active mass.

708,349. INSULATED RAIL JOINT; G. L. Hall, Brooklyn, N. Y. App. filed March 6, 1902. Blocks of wood are inserted between the fish plates and the rail end.

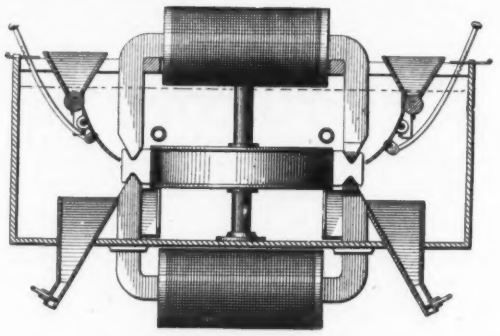
708,350. INSULATED RAIL JOINT; G. L. Hall, Brooklyn, N. Y. App. filed April 8, 1902. A modification of the preceding patent.

708,372. AUTOMATIC ENGINE STOP; N. C. Locke, Salem, Mass. App. filed Jan. 2, 1902. Circuit closers are placed adjacent to the fly wheel and cylinder head so that in case of rupture the circuit will be closed and steam cut off.

708,398. ELECTRICAL GAS LIGHTER; J. G. Poppert, Milwaukee, Wis. App. filed Jan. 7, 1902. Details.

708,432. INCANDESCENT ELECTRIC LAMP; Glenn Cannon Webster, Warren, Ohio. App. filed Dec. 30, 1901. In order to produce a symmetrical distribution of light a double spiral filament has its bottom loop attached to an anchor and the convolutions symmetrically arranged opposite each other and at different distances from the anchor.

708,462. VEHICLE TO BE USED IN ELECTRIC TRACTION ON RAILWAYS; G. Cawley, Westminster, England. App. filed June 3, 1902. Construction of a vehicle adapted to carry boiler, engine, dynamo and motor for electric traction.



708,185.—Magnetic Separator.

708,478. ELECTRICAL POSITION INDICATOR; A. S. Hubbard, Greenwich, Conn. App. filed Feb. 20, 1902. The invention comprises a movable index armature device having a magnetically polarized part and a fixed field magnet having a series of magnetizing coil sections whereby its field or line or axis of polarization may be varied or shifted so as to cause the armature to move, electrical contacts controlled by the movement of the object whose position is to be indicated, and connections from said contacts to said coil sections whereby the direction of the field axis and the position of the armature are determined by the position of said object.

708,496. BURGLAR ALARM; F. C. Robinson and J. E. Green, Council Bluffs, Iowa. App. filed Nov. 26, 1901. Details.